ELECTRICAL ENGINEERING

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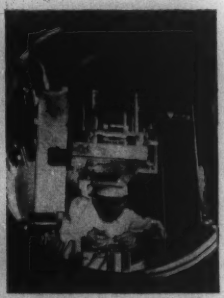

THE COVER: A 135-cryotron memory plane, which has been successfully duplicated many times by automatic control techniques, was reported by IBM. Scientists at IBM's Federal Systems Division laboratory in Kingston, N.Y., use the equipment shown for deposition. It allows each layer of a metal or insulator to be sequentially deposited through 17 microscopically adjusted masks, or perforated metal sheets. The masks are changed automatically like records in a juke box and are held in a large cylinder operating under high vacuum. Once the masks have been properly aligned, the process automatically produces the duplicate superconducting memory planes with similar electrical and mechanical characteristics. Story on p. 318.

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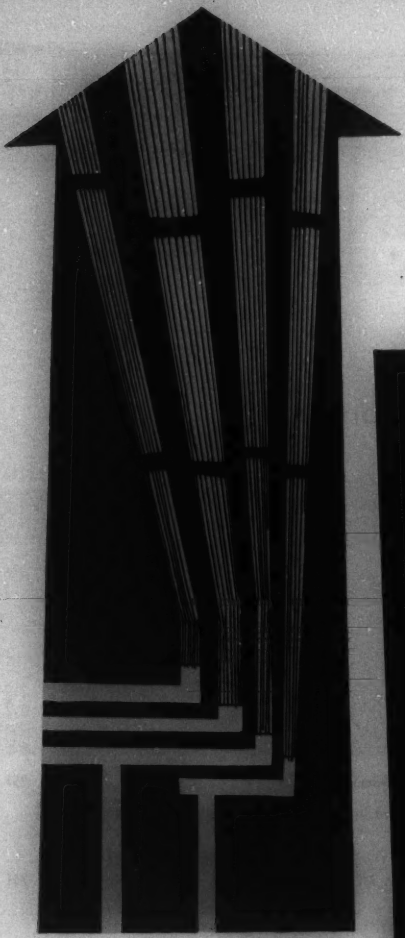

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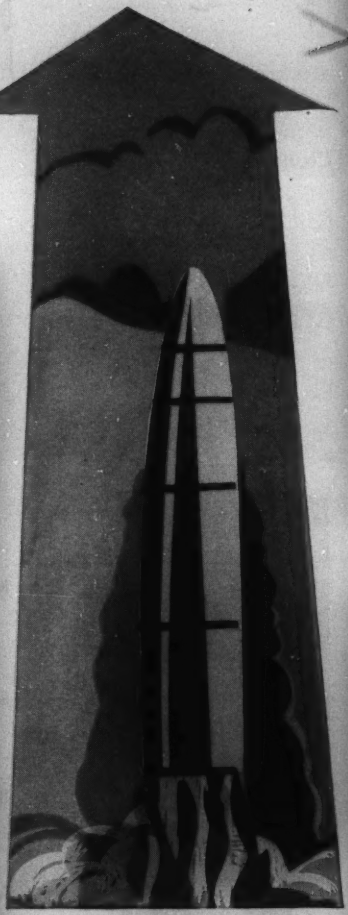

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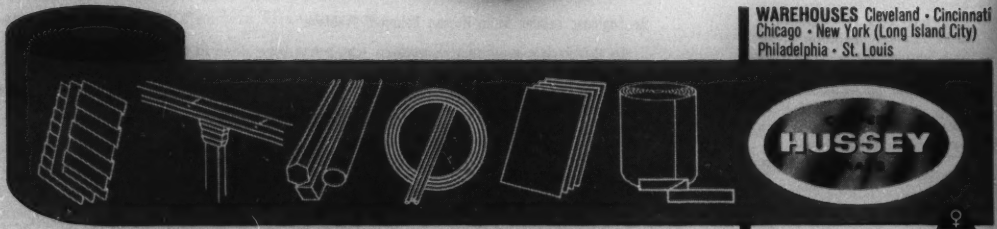

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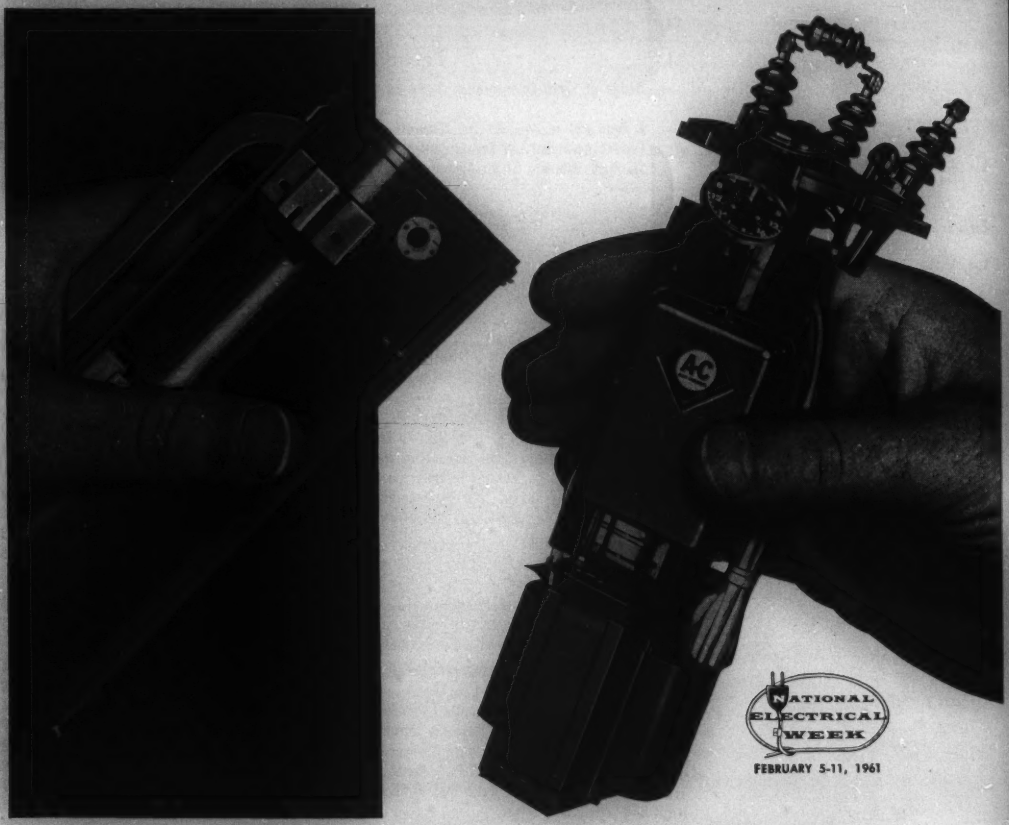

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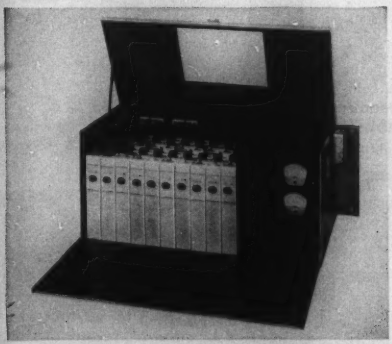

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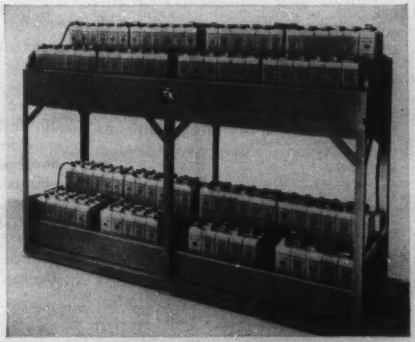

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packages. Complete circuit subassemblies using 1, 2, 3, or 4 port mounts with r-f bypass, ground return and/or bias provisions may be quickly assembled, while configurations such as series or shunt connected, double-ended cartridges, pigtail devices, *TO-18* and *TO-5* packages, and ceramic cartridges are merely placed in the appropriate Tri-Plate mount. *Sanders Associates, Inc., Nashua, N. H.*

Cable Tracer . . .

This new tester, called "Amprobe," will trace up to 10 conductors or pairs at one time without the need for buzzers, bells, or a helper. In operation, the ends of the conductors to be traced are plugged into the station blocks. The other ends are plugged into the tester. Numbers on the tester corresponding to the numbers of the station blocks light up to identify the conductors.

Since only one light can go on at a time, there is no chance for error. Self-powered, the device also offers the serviceman or contractor a foolproof way for testing opens and shorts as well as providing a method by which one man can do a job formerly requiring two. *Pyramid Instrument Corp., 630 Merrick Rd., Lynbrook, N. Y.*

Compact Calculator . . .

This new lightweight calculator designed for "on-the-spot" answers to every type of mathematical operation, combines the accuracy and speed of a large desk calculator with the portability of a slide rule. It has a capacity of 11 digits on the keyboard, 8 digits on the indicator dial and 15 digits on the answer dial. The main barrel assembly contains the horizontal digit keyboard with color-coded setting knobs and

movable white decimal markets. A number set on the keyboard remains unaltered until a calculation is completed. The knurled carriage contains the revolution counter, result dial, and additional decimal markets. A single level will clear the two dials, either simultaneously or individually. *The Curta Co., 14435 Cohasset St., Van Nuys, Calif.*

Dollar Bill Scanner . . .

A patented device for electronically scanning $1 bills at selected check points accepts only genuine bills face up. When a bill is inserted in the slot, a belt carries it past a photoelectric scanning eye as well as weight and size gauges to detect counterfeit bills. Genuine $1 bills drop into a space pro-

vided inside the machine where an electric circuit is closed allowing the vend button to be energized. Rejected $1 bills are politely returned to the customer from another slot. *Planetronics, Inc., Easton, Pa.*

Tankless Transformer . . .

Results of a research and development program by this company over the past several years indicate that encapsulated transformers in distribution ratings will eventually replace tank-contained oil-filled transformers on both overhead and underground systems. Greatly reduced weight and size, with consequent savings in installation time and cost, are among the resulting advantages. Recent prototype units

consist of core-and-coil assembly encapsulated by vacuum-pressure method in modified epoxy. Size reduction is illustrated by the kva identification "5" in the photo which is 2.5 inches long. *Pennsylvania Transformer Div., McGraw-Edison Co., Canonsburg, Pa.*

(Continued on page 26A)

The Challenges to Engineering in the 1960's

D. G. MITCHELL

Among the major challenges to the engineer in the next decade are increased emphasis on research and development, greater automation and mechanization of our manufacturing and administrative processes, and establishment of more manufacturing and service facilities abroad.

TODAY the engineering profession, particularly in the electrical industry, finds itself performing many different functions and focuses its attention on a wide variety of subjects extending far beyond the traditional technical borders. This is not solely because the electrical engineer of 1961 is quite a different type of engineer from his counterpart of 20 years ago, but also because the electrical industry itself has become, in effect, an industrial universe with all the overtones that description implies.

This has resulted in a rather curious paradox. It is abundantly clear that the impact of the electrical industry upon modern living is enormous. And yet the electrical industry—electric products and electric power alike—has become so deeply a part of this nation's everyday life that many of its contributions have long since been taken for granted, not only by the public but sometimes by the industry itself. It seems to me that we become so involved in our day-by-day problems and the search for their solutions that we tend to lose sight of the broader challenges and the greater goals. This is understandable enough, because those day-by-day problems can get relatively monumental at times, and there are only so many hours to arrive at the solutions.

Essentially full text of an address presented at the general session of the AIEE Winter General Meeting, New York, N. Y., Jan. 29–Feb. 3, 1961.

D. G. Mitchell is president, General Telephone & Electronics Corporation, New York, N. Y.

Everything is changing so rapidly in this world of ours that we are faced with a host of new and more complex problems every passing day. In view of this trend toward increasing speed and increasing complexity, are we devoting enough broad-gauge attention to preparing for the challenges of tomorrow? Excuse me if I belabor the point just a little, and I am sure you have all heard many times the story of two bricklayers on the same job. You will recall that a bystander asked what they were doing. The first man said he was laying up a brick wall. The second man said he was building a cathedral.

That is what I meant by the words "broad-gauge attention." Is the electrical engineer intent on merely building a brick wall no matter how strong and lasting it may be, or is he concerned with the broader aspects of the effect of new and better approaches to engineering upon the world of the future.

I am not concerned with the quality of the "brick wall." Without question, it will be the best that human ingenuity can devise. But will it be based upon new approaches and new concepts to meet the new demands of the future?

It seems to me that the solution is a resurgence, a revitalizing if you will, of the kind of pioneering that gave birth to the electrical industry just about a century ago. But it will have to be a new kind of dynamic pioneering geared to an entirely new set of situations, occurring not only here in the United States but throughout the world.

Our industry has had more than its share of pioneers —men such as Thomas Edison, George Westinghouse, Frank Sprague, William Stanley, and many, many others. These were the men who took electricity out of small laboratories and the workshops and put it to work, and it has been working at greater and greater

speed, with greater and greater magnitude, and with steadily increasing diversity ever since.

These pioneers would be the first to say that no small group of brilliant men produced the electrical industry and all of the related industries that have sprung from it over the years. And no small group has produced the tremendous achievements of the past two decades. Progress in a great industry—the progress that is so evident today and which will be projected far more broadly in the future—evolved from monumental and painstaking work on the part of millions of people. That is what Edison had in mind when he said "Genius is about 2% inspiration and 98% perspiration."

I am sure that many of you have noticed that a certain pattern of activity becomes increasingly evident as you explore the development of any large industry, and it is particularly true of the electrical industry. First, there is the accumulation of basic information, not only the specific knowledge in a given area, but broad and fundamental knowledge in physics, chemistry, metallurgy, and so on. Formally and informally, very frequently quite accidentally, this information is applied. It is put to work to solve some old problem, or perhaps it ends up by unearthing some new problem you did not know even existed. These new ideas and new ways of doing things enable some person or some company to do something it has never been able to do before. Then the feedback process begins. The end user of the new information broadens his own concepts and communicates back to the source, and the net result is that the state of the art broadens and improves again and again.

In other words, as a need is fulfilled, new needs come to light, and they in turn are fulfilled; and you have the chain reaction known as "progress." That is the story of the electrical industry, ranging all the way from the laboratories, to the manufacturing companies, to the utilities, to the consumer.

When you look for the more recent milestones in the electrical industry, it becomes a challenge of finding a logical milestone to separate from the thousands and thousands of others. And so you finally decide that you have to reach into the record and arbitrarily take out two or three milestones as typical of the many. You single out the development of high-pressure steam turbines, the fluorescent lamp, the cathode-ray tube from which came radar and television, gas turbines (which, of course, include aircraft jet engines), the all-electric locomotive, the particle accelerators, the computer, and many, many more. If you were to devise some way of charting these developments you would find in a very few minutes that the curve was becoming exponential and was going right off the top of the chart.

Sooner or later, you come to the realization that when you talk of the electrical industry you are talking about an industry that has more different characteristics than any other organized endeavor in modern life. It embraces not only the electrical sciences but every other science. Here is an industry that has made modern living extremely simple and at the same time rather complex. It has replaced some reasonably simple devices with some remarkably complex ones that do a great deal more, and in doing so it has changed the entire concept of what was being done in the first place. When an industry can do that, it certainly can be described as vital, and dynamic, and also completely fascinating to anyone fortunate enough to be a part of it.

GROWTH OF POWER OUTPUT

When I first started out in the industry with the Niagara Hudson Power Corporation 30-odd years ago, anyone who predicted that the consumption of electric energy would reach 700 billion kw-hr by 1960 would have been told to tone down his wild estimates or go look for another job. And yet you, and I, and the other 180 million people in this country set a new record by using 700 billion kw-hr last year.

It wasn't too many years ago—about 10 years ago, in fact—that the annual consumption was around 400 billion. Some of us decided to live dangerously, and we came out with the prediction that this country would be using 800 billion kw-hr by 1970. Some of the more conservative members of the industry gagged a little at that kind of blue-sky thinking, but they took it in good grace and kept their fingers crossed. Well, they uncrossed their fingers a couple of years ago, because, at the rate we are going, we will be up around one-and-a-half trillion by 1970—and if you extend the curve ahead to 1980, the total comes out to nearly three trillion.

Let's examine those figures a little more closely, and you will notice a phenomenon that symbolizes the electrical industry. Electrical manufacturing and electric energy consumption have developed a trend of doubling in every decade. It was 700 billion in 1960; the trend is now toward a trillion-and-a-half in 1970, and three trillion in 1980. On the other side of the fence, total shipments of electrical products have also been doubling every decade. From the utility side of the fence, you could say the doubling in their output produced the demand for the manufacturers. And the manufacturing companies could say they built up the load. Either way, I am completely happy with what is going on.

From the standpoint of the contributions made by the electric utilities, this has meant that they not only are meeting existing demands for electric power but, even more importantly, they are gearing their operations to the future growth of their service areas, and they will have the power there when their consumers want it. That kind of leadership is absolutely vital, and the utilities should be congratulated for it.

Now, we can talk about doubling our shipments of electrical products and our output of electric power, but all of this presupposes that the electrical industry faces up to a new host of challenges that are more varied, more far-reaching in their impact, and more perplexing than any which we have ever had to face before.

For example, here we are in 1961, in the second year of a decade that will provide unprecedented opportun-

ities for the United States and its industries. For years, American industry has effectively set the pace for the rest of the world, but now the situation has changed. We are at the crossroads today; we have the choice of participating in the growth and development of the world market and continuing to be the leading factor in the world economy, or we can miss this opportunity and gradually be outdistanced by our competitors throughout the world. Yes, this is a new situation for American businessmen; but it is also a new situation for all of us Americans, because the great advances in communications, in the ability of the people of the world to maintain effective contact with one another, together with the rapid advances in all branches of technology, have combined to eliminate effectively the obstacles of time and distance which in years past inhibited world trade. The trade horizons of every country have greatly broadened, and businessmen throughout the world are seeing opportunities for increased trade that they never saw before.

OPPORTUNITIES AND CHALLENGES

HERE I would like to get more specific about these opportunities and challenges. Let me list them first, and then we can examine each of them more closely.

1. We must place greatly increased emphasis on research and development or, to put it another way, innovation and invention. Aside from constantly improving our goods and services, and producing them at competitive costs, we have the even greater challenge of developing entirely new products and services, new ways of making them, and new ways of marketing them to customers next door or on the other side of the world.

2. We must assure far greater automation and mechanization of both our manufacturing and our administrative processes. This is the key to the higher volume, lower cost, greater flexibility, and higher efficiencies which we will need to compete in the world markets.

3. We must adapt our operations more effectively to our existing and potential markets. Thus, for example, if a market exists overseas and the best way to take advantage of that opportunity and to meet competition is to establish manufacturing facilities overseas, a company should be flexible enough to do just that. In other words, world-wide markets require a world-wide viewpoint, and that frequently means changing some ideas and practices we have had for years.

RESEARCH AND DEVELOPMENT

FIRST, let us look at research and development. When we talk about the future of our economy, we customarily talk in terms of the gross national product and its annual rate of growth of 3 or 3½%. Now, this, of course, affords an excellent measure, especially in comparing past and present performance. But there is an intangible which we should also factor in; that is, the steady progress in technology—refining and improving our products and developing new principles, new designs, new materials, and new efficiencies. In other words, economic growth comes not only from gradually increased consumption of traditional products and services, but also in the consumption of entirely new products. That is where the big potentials are.

When you bear in mind that it takes from 7 to 10 years on the average to translate the findings of research into a new product, and that from 50 to 75% of the products of many large companies today are completely or radically different from their products of 15 years ago, you can see why the emphasis on research has increased so drastically in recent years. Back in 1941, the total spent throughout the economy on research was less than $1 billion annually. Today it is at the annual rate of more than $14 billion, and the total is climbing all the time.

As you will recall, research for many years was identified almost entirely with the highly technical industries. However, the picture has changed and we now find an almost universal interest in research throughout industry, not only in manufacturing, but also in transportation, agriculture, mining, and most recently in distribution. But this interest, great as it is, must be accelerated and strengthened, and we must find ways of at least doubling our research spending over the next few years. The challenge is as simple as this: What we do in our laboratories today, tomorrow, and next year, and the skill and speed with which we apply those research findings, will determine the position the United States will hold in the critical latter years of this new decade. The seeds for the new products which you hope you will have 7 or 8 or 10 years from now must be planted now. You can be sure that some excellent planting is going on right now in the laboratories of Western Europe and Japan.

AUTOMATION

LET US examine the second challenge: the need for greatly increased automation. Here we have the key to higher volume, lower costs, greater flexibility, and higher efficiencies. You and I know that making more of a given product is only part of the story, and in certain market situations it may even be the last thing we want to do. But getting lower and lower costs is something else again, because a big potential danger for us American businessmen is finding ourselves priced out of the world market. The challenge can be boiled down to this: Those of us in the manufacturing side of industry must generate obsolescence in our production processes and develop more efficient and less costly processes just as fast as we can. If we do not, foreign prices will put us right over a barrel.

As many of you are aware, that word "automation" fascinates many people; but it also scares a great many, and has provided an excellent bogeyman for the demagogues. They conjure up the vision of great numbers of our working force being thrown out of work, but what they ignore consciously or unknowingly is an unassailable fact: Machines remove drudgery; they do not

remove jobs. Certainly, there are short-term dislocations, and avoiding or resolving those situations requires every bit of managerial skill we can apply. But the end result of automation in the manufacturing plant is the elimination of obsolete jobs, and the creation of new, better, higher-paying jobs.

When you get right down to it, the plants and equipment we have in industry today could never begin to do the work required of them as our country grows and its demands for new and improved products continues to expand—all of this, incidentally, in the face of intensive price competition from overseas. Aside from at least maintaining our present rate of automation, we will have to do an even bigger job. When you think in terms of our exploding population, which will reach 200 million by 1970, and the steadily rising living standards of those people, and a gross national product moving toward $750 billion by 1970, you can see why every businessman in this country will have to gear his thinking and his doing to an entirely new set of demands.

By projecting our existing growth rates into the future we see that automation will have to fill 20 million job vacancies in the next 20 years, because there will not be enough people available for the working force to produce the goods and services our country will need.

The opportunities to use automation to keep our costs in line and for its many other benefits is not restricted by any means to the manufacturing side of the business. On the administrative side of the business, one of management's biggest challenges is to get more useful information in time to utilize it.

All of us know that the great emphasis these days is on speed and more speed. This has been the natural outgrowth of this country's expanding economy and the trend toward a higher and higher standard of living. Meeting those demands has made every aspect of business today incredibly more complex than it was only 10 years ago. However, greater speed alone is not the answer, because that can mean we run faster but that we run in the same tight circles. What we need is better information, and we need it sooner. The way our economy is geared these days, there is less and less time between the events that affect our business, and since we in management have to base our decisions on those events as they are reported to us, we need better information, not more information, and we need it in time to do something about it.

Electronic data processing has made great strides in solving this problem and a great many things have been learned, but we have only scratched the surface. One thing we learned early was that in spite of its versatility, its remarkable memory powers, its speed, and its relative freedom from error, a computer cannot think. It can act only on the information given it by man. If you ask it a silly question, you will get back a very silly answer.

True, a computer can do its job faster than man. It can do its job more accurately than man. In the accomplishment of the tasks put to it, it is more efficient than man, but it still is a tool. I recall several years ago when we were just starting data processing in our company and I visited our big computer room. The boys had been having a little trouble asking the computer the right questions, and the computer was having a little trouble coming up with the right answers. In other words, we were feeling our way in a new field. As I looked at the computer I noticed something in a glass frame attached to the computer cabinet. Inside the glass case was an abacus, and below the glass was a little sign: "In case of emergency, break glass."

Needless to say, great improvements have come since then, and tremendous social and economic gains will come from administrative automation, particularly in capitalizing on opportunities of which we are not even aware today.

OVERSEAS EXPANSION

THE THIRD major challenge is that of overseas expansion, i.e., the establishment of manufacturing and service facilities abroad in order to participate in the expansion of markets overseas. It seems to me that there has been a great tendency to regard the rebirth and growth of the economies of the free world purely from the standpoint of competition. Certainly, they represent new competition, but the broader and more important aspect is the opportunity to expand and develop our operations abroad so that we can serve these expanding economies.

Western Europe, for example, is far more than the six nations of the Common Market and the seven who comprise the Free Trade Association, all of whom are justifiably seeking to promote trade among themselves and with the rest of the Free World. Far more importantly, Western Europe, with a total output of goods and services roughly equal to 60% of the United States total, represents enormous opportunities for American industry, just as the United States has provided opportunities in the past for European industry. Here is our greatest opportunity and our greatest challenge—the economy of Western Europe, which has a far greater potential than the Soviet Union and the Iron Curtain countries.

These opportunities overseas have not passed unnoticed. During the past 8 or 9 years, American industry has doubled its investment in operations abroad, and the net result is that total sales of products made by United States plants overseas are rising faster than exports from the United States. What this all adds up to is that at least 3,000 American companies have invested some $50 billion in foreign manufacturing and marketing, and nearly $30 billion alone is invested in operations in which American companies have a 25% or greater interest.

Because of the magnitude of this investment, there is every probability that sales from overseas operations will at least double in the next 10 years. Frankly, that estimate is probably too conservative, and the increase could well be threefold, particularly in Western Europe. You can rest assured that the increase will be sub-

stantial, because United States private investment is climbing steadily in Western Europe and today is up around $5 billion, or three times the total of 10 years ago. Based upon the trend that has been established, a figure of $6 to $7 billion could be reached in the next 3 or 4 years. Again that could well be conservative, since American manufacturers are putting nearly 50% of their overseas capital expenditures in Europe.

In looking at the trade potential in Western Europe, we cannot, of course, disregard the trade barriers which are inherent in a common market. However, I do believe that most of the dislocations that do occur will be relatively short term, and there will be no great permanent detriment to outside countries. The important point to bear in mind is that we in the United States are in an entirely different economic situation than we have ever encountered before, and we will have to adjust to it. It will require plenty of give and plenty of take, but haven't all of us been doing precisely that for years? The ball game will be the same; the only difference will be that we will be playing more games on the other team's home grounds.

CONCLUSION

WE HAVE BEEN looking at some rather impressive trends for tomorrow, and there certainly is no question about the direction in which the electrical industry is going. I wish we could leave it at that. Unfortunately, however, these trends I have been describing all presuppose one basic thing: They presuppose that the entire economic climate during the 1960's will be right. After all, these are tangible opportunities, but as in the case of any opportunity that is really worth anything, there are some equally great challenges standing in the way.

Dynamic and effective as the electrical industry may be, it cannot do the job alone. It can carry the ball only so far, and then it runs smack up against some factors over which it has no direct control. Here is the crux of the situation. Every major segment of our economy must devote far greater attention than ever before to the impact of its actions on the rest of the economy. None of us—industry, government, labor—can act in a vacuum and go all out for itself alone. That kind of narrow self-interest will only wreck this country.

Thus, if management fails to apportion the benefits of greater productivity on a fair-sharing basis among shareowners, employees, and customers, if labor takes all of the productivity increases in the form of higher wages, if government keeps increasing the tax load without making sure that it has first eliminated waste and extravagance of its present tax revenues, then there will be nothing left for anybody.

Every businessman is faced with the challenge of doing everything he possibly can to assure a favorable business climate. I don't mean a climate that is favorable only to businessmen, but a climate that works for the benefit of everybody—the people who own businesses, the people who work in them, the people who buy from them, and everyone else.

That is my challenge, and it is a challenge that we will have to meet head on if the electrical industry is to turn those wonderful opportunities of the 1960's into real progress for this country.

We must concentrate far more on finding entirely new ways of doing things, we must be prepared to discard traditions and the "sure thing" if we know down deep within us that there are better ways to do it. And if we don't know of better ways to do things, we simply aren't looking hard enough.

The next several years will put us to the severest tests of our lives. But the brilliant past history of the electrical industry shows that any obstacle can be overcome through applied effort.

Large-Scale Computer Shipped Overseas

MOBIDIC (Mobile Digital Computer), developed and produced by Sylvania Electric Products, Inc., for the U. S. Army Signal Corps, is loaded aboard the *USNS Comet* at Brooklyn, N.Y., for the second leg of a 3-stage journey from Needham, Mass., to Germany. Destined for use at the Seventh Army Stock Control Center in Zweibrucken, West Germany, the MOBIDIC system contained in three 30-foot Army trailer vans was placed aboard the specially designed roll-on/roll-off ship for the voyage to St. Nazaire, France, where it will be driven off the ship and over land to Germany. The system, designed to move with and support the field army, will control thousands of requisitions for replacement parts for rockets, guided missiles, electronic warfare, air defense, combat surveillance, or atomic artillery.

The Optical Maser

C. G. B. GARRETT

A brief description is presented of a solid-state device, a ruby maser, that utilizes the principles of microwave amplification by stimulated emission of radiation (maser). Experiments under way point to a new medium of communication in which a beam of light is used to transmit vast amounts of information from one point to another.

THE principles of microwave amplification by stimulated emission of radiation have been known for several years. A solid-state device using these principles, a ruby maser, was used during 1960 in practical application in the communication experiments with Echo I, the passive communication satellite. Now, the maser principle has been extended to the optical frequencies, and the first practical application has again been in communication.

An optical maser was used in preliminary experiments in long distance communications in mid-September 1960, by scientists at Bell Telephone Laboratories. The device transmitted pulses of light between the Laboratories' locations at Holmdel, N. J., and Murray Hill, N. J., a distance of about 25 miles (Fig. 1). The light emerging from the ruby optical maser was directed at the Murray Hill laboratories, where the red flashes were clearly visible to the naked eye. They also registered on photomultiplier tubes. The circle illuminated by the beam at Murray Hill was only about 200 feet in diameter.

Experiments were also conducted in which the pulses of light were transmitted along a quarter mile of 2-inch diameter buried circular waveguide, where the dust and fog of the atmosphere could not attenuate the light beam. This waveguide had already been installed underground at Holmdel, for use in microwave and millimeter wave communication experiments. Photomultiplier tubes at the waveguide end recorded clear pulses of high-intensity light.

OPERATION

THE OPTICAL MASER produces an intense and extremely narrow beam of light. Within its narrow cone and frequency band, the beam is more than a million times brighter than the sun. The light generated by the maser is "coherent"; that is, light in which a definite phase relationship exists from point to point in all parts of the beam. Since it is the property of coherence in radio waves which makes it possible to control, direct, and modulate them, it may also be possible to use coherent light in the same way. In that event, a beam of such light could be used to transmit vast amounts of information from one point to another.

The basic concepts of the optical maser used in the experiments were disclosed by A. L. Schawlow and C. H. Townes in a paper published in *Physical Review* in December 1958, as well as in a recently issued U. S. Patent (2,929,922). In these documents, the authors proposed extending the maser principle from the microwave frequencies at which it first operated to the much higher frequencies of the infrared and visible light spectrum. Various extensions of the maser principle have also been discussed by many others, including Bloembergen, Dicke, and Prokhorov.

The heart of the Bell Laboratories optical maser is a synthetic ruby rod, 1½ inches long and 1/5 inch in diameter. This material was originally proposed for use in optical masers by Schawlow, and was used in the manner originated by T. H. Maiman of Hughes Research Laboratories, who first observed optical maser effects in ruby. The two ends of the rod were polished until extremely flat and parallel, then covered with a reflecting layer of silver thin enough to be slightly transparent. This ruby rod was held in the center of a spiral photoflash of ordinary white light (Fig. 2).

The investigators, R. J. Collins, D. F. Nelson, A. L. Schawlow, W. L. Bond, W. K. Kaiser, and the author, found that when the power applied to the flash lamp exceeded a certain value, a nearly parallel beam of light was emitted through the silvered ends. This light was red, like the ordinary fluorescent light from ruby, but differed from it in several important ways. First, it was sixty times closer to being "monochromatic" (of a single frequency) than the ordinary fluorescent light from ruby.

Secondly, the light was shown to be coherent. This was demonstrated by arranging two fine, parallel slits in a thick silver coating on one end of a ruby rod. The pattern of emerging light showed that the light from one slit was "interfering" with the light from the other, indicating that the emitted light was in phase across the end of the rod.

Thirdly, almost all of this monochromatic light was emitted within a cone angle of only one-tenth degree. Within this cone, the intensity of the light was far higher than could be obtained by the ordinary fluorescent process.

In addition to these observations, all of which were suggested in the Schawlow-Townes Patent, the coherent light was found to be emitted in intense short bursts, each in the order of a millionth of a second long. With the present flash lamp, maser action could be sustained

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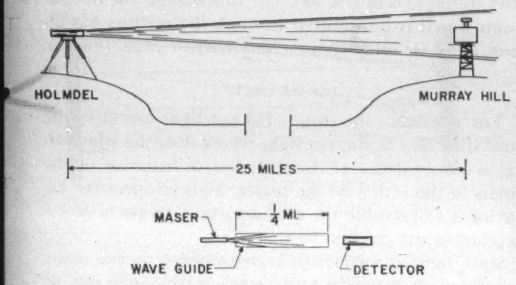


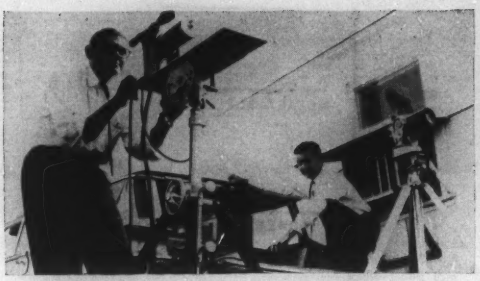


Fig. 1. (*left*) Experimental set-up for tests in long-distance communications. (*right*) Bell Telephone Laboratories scientists at Holmdel, N. J. line up an optical maser prior to a communication experiment between Holmdel and Murray Hill, 25 miles away.

for about a thousandth of a second, during which several hundred of these bursts were observed.

BASIC PRINCIPLES

TO UNDERSTAND the operation of the optical maser, one must first understand the phenomenon of fluorescence. A fluorescent material is one which, on exposure to light of some frequency or band of frequencies, emits light of a different frequency. The frequency of the emitted light is almost always lower than that of the existing light. The coating on the inside of a fluorescent lamp tube, for example, accepts ultraviolet light and gives out lower frequency visible light. Similarly, a sample of ruby illuminated with green light emits a red light fluorescence of a fairly sharply defined lower frequency.

Ruby is single crystal aluminum oxide, with a small fraction of the aluminum atoms replaced by chromium atoms. These chromium atoms are the source of its red fluorescence.

The optical behavior of atoms can be described in terms of the different amounts of energy, or "energy levels," which the atoms can possess. An atom at rest cannot store energy in continuously variable amounts; it can exist only in one of a well-defined set of energy levels. Ordinarily an atom will occupy the lowest of these possible energy levels. It can be raised to a higher level by the absorption of light, and from that "excited state" it can fall back to a lower level by the emission of light.

However, just as the atoms exist only in discrete energy levels, they respond only to light of specific frequencies. There is a close correspondence between these critical frequencies and an atom's possible energy levels. Each frequency is proportional to the difference in energy between two of the levels. When an atom is illuminated with light of one of its critical frequencies, it will absorb a "quantum" of that light and jump to a higher level. When it relaxes to a lower level, it may emit light. If it does, it will emit a quantum of light of a frequency corresponding to the difference in energy.

In the usual fluorescense of ruby, light in the green region excites some of the chromium atoms in the ruby to one of their higher energy levels. The atoms rapidly relax from this level to an intermediate level, but one which is still above the original lowest level. Then, somewhat more slowly, the atoms relax from the intermediate level to that lowest level, this time emitting quanta of red light in the process. The frequency of the red light is lower than that of the green light which originally excited the atoms, because the energy difference in the second jump down is less than the energy difference in the original jump up.

The level from which the chromium atoms take their second jump down, emitting red light, is often called "metastable" because the atoms are more reluctant to leave it than they were to leave the higher level to which they were originally excited. They eventually do leave it spontaneously, however, and thus provide the red light observed in the ordinary fluorescence of ruby (Fig. 3).

The optical maser uses the fact that the atoms can be "stimulated" to make the last jump more readily. The stimulated emission occurs when the atoms are bathed in light at a frequency similar to that which they would normally emit spontaneously. The stimulated emission of light, in contrast to the spontaneous emission, distinguishes the action of the maser from ordinary fluorescence.

In the optical maser, the atoms are excited to higher energy levels by the green component of the white light from the flash lamp. From there they rapidly drop to a metastable level without radiating light. Spontaneous emission from that level is relatively slow, but the light

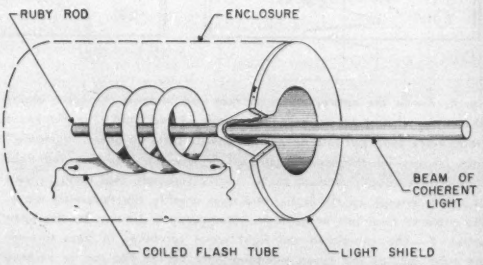


Fig. 2. Pulsed ruby optical maser.

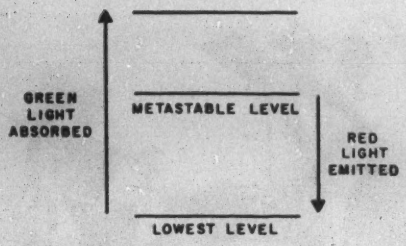


Fig. 3. Line narrowing of maser action compared with normal fluorescence.

given off by the few spontaneously emitting atoms is of the proper frequency to stimulate emission by the rest. In the Schawlow-Townes configuration, a wave of red light travels back and forth between the two silvered ends of the ruby rod, giving that light maximum opportunity to stimulate further red light emission from the metastable atoms. An intense radiation builds up, and continues as long as the population of atoms in the metastable state is constantly restored by "pumping" the atoms back up by the green exciting light (Fig. 4).

Only the light which makes many passes back and forth through the ruby rod stays in it long enough to accomplish much stimulation. Since the light which is stimulated moves in the same direction as the stimulating light, the only light which is strongly amplified is that which moves perpendicular to the mirrors, or parallel to the axis of the rod. For this reason, the output beam which is transmitted through the mirrors has almost all of its intensity in a very narrow cone (Fig. 5).

COHERENCE

THE FACT that the stimulated red light moves in the same direction as the red light which does the stimulating is one evidence of the co-operative behavior of the atoms in the action of the maser. This co-operative behavior is responsible for the important property of coherence in the emitted light.

Since light is an electromagnetic wave, it has many properties in common with other waves, and can be thought of in terms of a procession of crests and troughs, like waves on the surface of water.

An isolated atom, emitting a quantum of light, behaves like a pebble dropped into the water: a wave proceeds outward in all directions. Unco-operating atoms emit waves like those produced by many pebbles, dropping into the water at random places and at random times. The resulting disturbance is incoherent. This is the character of all ordinary light, including the fluorescent light usually given off by ruby.

On the other hand, in the maser the atoms co-operate in the same way that pebbles would if the crests and troughs in the waves from all the pebbles reinforced one another. Pebbles dropped at exactly the same place at just the right rate, for example, would produce such a coherent wavelike disturbance. The control over co-

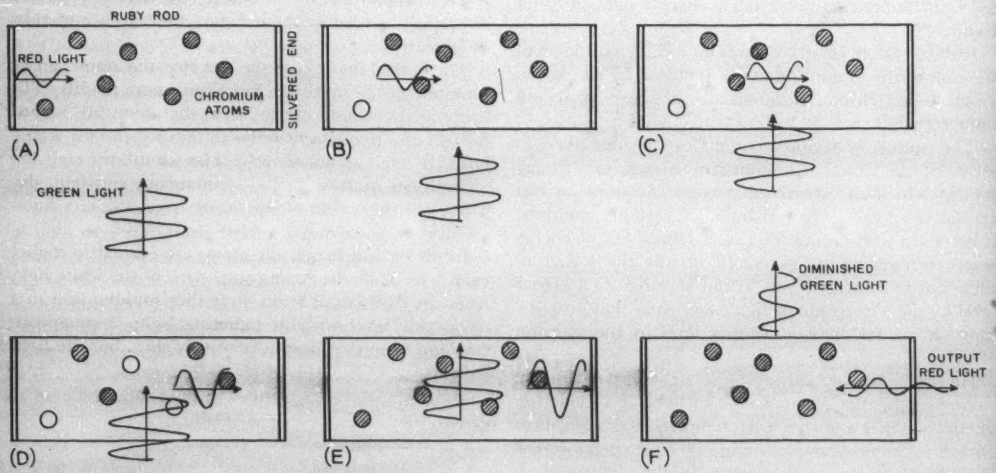
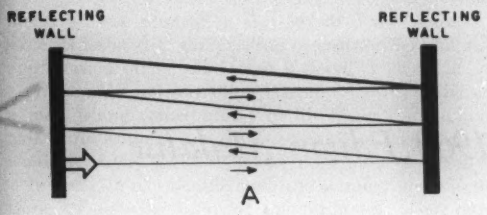


Fig. 4. A—In the optical maser, a ruby rod presents chromium atoms (shown by circles) to an oncoming wave of red light. The chromium atoms have been put into an excited energy state by green "pumping" light (shown by shading the circles). B—As the oncoming red light passes an excited chromium atom, it may stimulate that atom to emit its excess energy as red light, and thus amplify the oncoming wave. The atom is then left in its lowest energy state (shown by the open circle). C—The stimulated red light wave continues to pass through the ruby rod, as the green pumping light bathes the rod in exciting radiation. D—The amplified light wave stimulates emission from other excited chromium atoms with increasing effectiveness. But in any one pass through the rod it cannot stimulate emission from all the excited atoms. E—The green exciting light puts the atoms back into their higher energy levels, providing energy which may be stimulated to radiate during the next traverse of the stimulating red light. (No definite phase relationship between red and green should be inferred.) F—In order to stimulate maximum emission, the light wave is made to pass back and forth in the rod by reflection from the partially reflecting silvered ends. Red light which is transmitted through those mirrors forms the usable output.



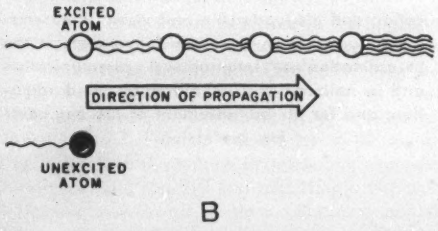


Fig. 5. A—Internal amplification of light energy due to multiple passes. B—Drawing illustrating the co-operative behavior and property of coherence between stimulated and stimulating light.

herence in light which is accomplished by the maser has not been available hitherto.

MONOCHROMATIC LIGHT

ANOTHER SIGNIFICANT POINT is the fact that the light from the maser is much more nearly monochromatic than the usual fluorescence of ruby. This narrowing of the band of frequencies emitted is an expected result of stimulated emission. While light emission can be stimulated by light of slightly different frequency from the central frequency expected, stimulation by the central frequency is most effective in returning atoms in the metastable state to the lowest energy level. Furthermore, in dropping to that level, the atoms emit more light at the central frequency than at any other (Fig. 6).

Thus, the intensities in the band of output frequencies are more sharply peaked around the central frequency. At present, experiments of Bell Laboratories have demonstrated a band-narrowing effect of a factor of sixty over the usual fluorescence band of ruby. Much larger narrowing factors are expected soon.

In its present form, the maser emits light in closely-spaced short bursts. Each burst is less than a millionth of a second long, and the bursts are spaced only a few millionths of a second part. It is this fact that indicates the possibility of modulation of the signal, so that it may eventually be used as a carrier frequency in communication (Fig. 7).

One way in which this behavior might be explained is as follows. This intensity of the light confined within the rod may tend to build up to the point where it stimulates emission. It begins to depopulate the metastable state so rapidly that the green light of the exciting lamp is no longer able to maintain a sufficient population of atoms in that state for the co-operative action of the atoms to continue. Then the radiation abruptly dies down, until the exciting lamp can restore that population. The extremely rapid pulsing of the light thus results from the alternating depletion and restoration of the active population of atoms.

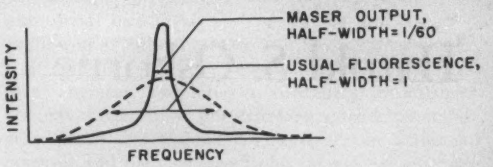


Fig. 6. Pumping action of exciting light to high energy level followed by nonradiative decay to metastable level.

RESEARCH BEING INTENSIFIED

NOW THAT THE FAVORABLE PROPERTIES of ruby have been revealed, we are actively exploring means for extending the techniques of modulation, amplification, and detection, long exploited in radio communication, to the much higher frequencies of the radiation from the optical maser. A program of research on the luminescent properties of other materials suitable for operation at other optical frequencies is also being conducted.

For example, in addition to the research on solid-state optical masers, A. Javan, W. R. Bennett, Jr., and D. R. Herriott at Bell Laboratories are collaborating in a program work on gaseous systems. Recently, these workers have reported the achievement of a continuously operating gas maser, using a mixture of helium and neon as working substances. (See p. 314 for report on continuously operating optical maser.)

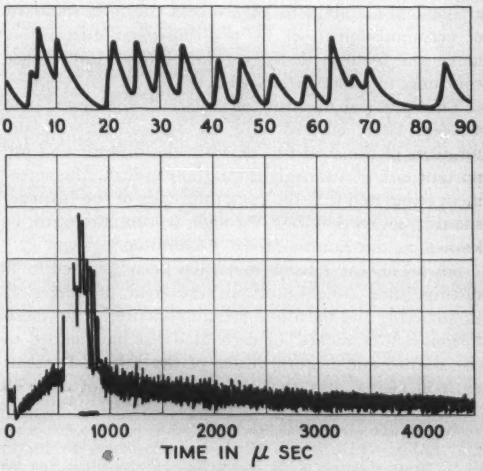


Fig. 7. Beam of microsecond pulses of light energy.

Harold S. Osborne

1960 Edison Medalist

"For his contributions to the art of telecommunication and his leadership and vision in extending its application; for his achievements in the co-ordination of international communication and in national and international standardization; and for his advancement of the engineering profession."

History of the Medal

C. M. MAPES
FELLOW AIEE

THE DAY was October 21, 1879. A fragment of carbonized cotton thread in a small globe began to glow and a giant new industry was born. The man responsible was Thomas Alva Edison.

On February 11, 1904, to commemorate the achievements of a quarter of a century in the art of electric lighting, a group of Edison's friends and associates created a medal in his name. The "Edison Medal," they wrote ". . . should, during centuries to come, serve as an honorable incentive to scientists, engineers and artisans, to maintain by their works the high standard of accomplishment set by the illustrious man whose name and features shall live while human intelligence continues to inhabit the world . . ."

The American Institute of Electrical Engineers, some 4 years later, entered into an agreement with the founders of the award to perform the difficult and important task of awarding the Edison Medal. The agreement stipulated that the responsibilities of the Institute should be carried out through a committee to be known as the Edison Medal Committee.

Since 1909 the Edison Medal has been awarded to 49 distinguished contributors in the field of Electrical Engineering and the allied arts and sciences. The "meritorious achievements" of each Medalist have added to the stature and historic luster of the award. It seems entirely fitting, also, that the contributions of these 49 men have encompassed virtually every important facet of electrical engineering. Such is the scope of the Institute and such was the scope of the life and work of Edison.

It is my very great pleasure and honor to announce on behalf of the Edison Medal Committee, their unanimous selection for recipient of the 50th Edison Medal. We are certain that, once again, the Medalist's name will bring credit to the Institute's highest award as his contributions have brought credit to his profession. The 1960 Edison Medal is to be presented to Dr. Harold S. Osborne.

Career of the Medalist

H. I. ROMNES
FELLOW AIEE

THOSE OF YOU who know our medalist will not envy me my assignment. To compress even the highlights of Harold Osborne's career in a 10-minute span might just possibly be within the capacity of the very latest high-speed data processors. Certainly it is beyond mine.

First of all, there is the question "which career?"

Should I spend this brief interval telling you about his technical accomplishments, only partially reflected in the 35 patents which bear his name?

Or should I tell you about Harold Osborne as an administrator, as a leader of engineers, as an imaginative planner who contributed so largely to the firm sense of direction which has characterized the telephone industry's technical progress?

Or should I tell you about Harold Osborne's contributions to his profession, the many responsible assign-

Presentation and acceptance addresses made at the general session of the AIEE Winter General Meeting, New York, N. Y., Jan. 29–Feb. 3, 1961.

C. M. Mapes, chairman of the Edison Medal Committee, is with the American Telephone & Telegraph Company, New York, N. Y.

H. I. Romnes is president, Western Electric Company, New York, N. Y.

ments he has assumed in this Institute and in other societies devoted to the progress of engineering and an appreciation of its role in our society?

Or should I tell you about Harold Osborne, citizen—a man whose contributions to his home community and to his country constitute a record of service that would represent a full-time career for most of us?

In the face of this dilemma, the simplest and safest thing to do is to begin at the beginning when our medalist's career presented fewer facets to the biographer. Harold Osborne was born in 1887 in Fayetteville, N. Y. From here on, though, the plot thickens.

He attended Massachusetts Institute of Technology, receiving his degree in electrical engineering in 1908 and his doctorate in 1910. Immediately thereafter he joined the American Telephone and Telegraph Company and embarked on what would prove to be a 42-year career in the telephone business. Name the major areas of technological progress in telephony over the last five decades and you will find that Harold Osborne had a leading role in all of them. Transcontinental telephone service, mechanical switching, multiplex telephony, the application of radiotelephony to overseas service, the vast network of coaxial cable and microwave radio relay for television and for telephone calls, long-distance dialing on a nation-wide basis—all of these bear the stamp of his inventive genius or his firm direction, or both.

The first decade of Dr. Osborne's Bell System career, the period from 1910 to 1920, was an era in telephone history most notable for progress in extending the range of telephone transmission. The young Harold Osborne played a leading role in the first extension of long distance service across our country. His transmission studies, the instructional bulletins he prepared and the test methods he designed helped lay the foundation of standard equipment and standard practice without which an integrated nation-wide telephone network could not have been achieved.

From 1920 to 1939 Harold Osborne was the American Telephone and Telegraph Company's transmission engineer. This was the period when a truly universal, nation-wide telephone network came into being. This culmination of Dr. Bell's dream of universal service depended on the development of a general toll switching plan; and this was Harold Osborne's work. His criterion for the plan was simply this: it must provide for quick and orderly interconnection of any two of the nation's tens of millions of telephones, however far apart they might be, with assurance of high-quality transmission. The nation-wide telephone network has been growing according to that plan and that standard ever since. Also during Harold Osborne's term as transmission engineer, long distance call capacity was multiplied many times over through the application of carrier telephony—first with 4 simultaneous conversations on a pair of heavy wires strung on poles, then 12 on a pair of fine wire in cable and, finally, hundreds of channels on coaxial cable. Also in this period, radiotelephone circuits across the oceans were established on a commercial basis, thus eliminating the last barrier to world-wide telephone service.

In 1940, Dr. Osborne's responsibilities expanded. As plant engineer, and later as assistant chief engineer, not only transmission, but switching, outside plant, and other phases of telephone engineering came within his domain. And the challenge to his talents was a formidable one: do a bigger job with less. Short of material, short of men, the Bell System was called upon to carry a bigger load of vital communications to meet the war emergency. Harold Osborne's vigor and ingenuity helped us do it.

Finally, in 1943, in the midst of the war years, Harold Osborne became chief engineer of the Bell System, a post which he occupied until his retirement in 1952. He served with distinction; but the word doesn't begin to do justice to the energy and technical vision he brought to the job.

A SENSE OF THE WHOLE

WERE I ASKED to name that one attribute which above all others has made Harold Osborne the great engineer he is, it would be this: his ability to see the problem whole. His is that rare vision which sees through to the fundamental principles underlying the most complex technological undertakings. Not only does he have the vision, but also the firmness of purpose to hew to those principles.

During Harold Osborne's tenure as chief engineer, the Bell System was confronted with unprecedented challenges. Witness the explosive growth requirement that burst upon us in the post-war years. Witness, too, the enormous plant construction program involved in meeting this growth and in the installation of a vast network of coaxial cable and microwave radio to provide broad bands of frequencies to carry hundreds of telephone messages as well as network television. All in all, in the 10-year period when he was chief engineer, the Bell System nearly doubled the number of its telephones, spent more than $8.5 billion for new construction.

But nowhere is Harold Osborne's clear technical vision, his "sense of the whole," better demonstrated than in his role in connection with the Bell System's toll dialing program, an undertaking continental in scope calling for the investment of billions of dollars over many years and calling for the co-ordinated efforts of literally tens of thousands of people. Harold Osborne defined the goal—nation-wide direct distance dialing—and set in motion the studies which provided the master plan for this enormous project. I think it is fair to say that it is largely as a consequence of the scope and power of his technical imagination that today any one of 30 millions of Bell System telephones may, with a few turns of the dial, be connected with any other of tens of millions of telephones, all in a matter of seconds.

I have done scant justice to Harold Osborne's telephone career, and none at all to his other careers. Of his service to engineering, I can give only the briefest account. He was, as you know, president of this Insti-

tute in 1942-43, but before and since he has been a member of numerous committees and boards and chairman of at least seven. He is a fellow of the Acoustical Society of America, the American Physical Society, the American Association for the Advancement of Science and as Yul Brynner says in "The King and I"—etcetera, etcetera, etcetera. He has been a vice-president of the American Standards Association, chairman of two key committees of the Engineers Joint Council, and president for 3 years of the International Electrotechnical Commission.

STANDARDIZATION

I HAVE more than once mentioned Harold Osborne's concern for standardization. He saw it as the key—as indeed it *is* the key—to an integrated communication network, and to progress in many other fields, too. His concern transcends national boundaries, and it is well that it is so. For example, his devoted work over many years of patient technical negotiations in connection with the International Telephone Advisory Committee, better known as CCIF, represents a unique contribution, unmatched by any single individual, to the goal of global communications. As more and more ocean cables interconnect the continents, as we look forward to the certain prospect of intercontinental communication via satellite relays, we have more and more occasion to be grateful for the groundwork of common standards Harold Osborne did so much to establish.

If Harold Osborne's technical vision is global in scope, he has not neglected responsibilities closer to home. In his own person he evidenced his expressed conviction that engineers, by virtue of their training, their disciplined objectivity, have unique opportunities for service to their communities. As just one example, Harold was, from 1933 to 1940, chairman of the Planning Board of his town, Montclair, N. J. His dedicated interest in bringing order and sanity to the almost agonizingly complex problems of community growth brought him national eminence in this field. He has been president of the American Society of Planning Officials and president of the Regional Plan Association. Harold has been in this work for many, many years. Now, belatedly, more and more of us are beginning to see how the times cry out for the kind of intelligent and responsible citizen initiative he demonstrated a long time ago.

And one thing more. Harold Osborne has always been future-minded. Not what happened yesterday but what is going to happen tomorrow is his concern. I recall that on the eve of his retirement after 42 years he was asked to write an article for the *Bell Telephone Magazine*. The editor probably anticipated a retrospective swan song, a review of how we did it way back when. The article the magazine received and published was something else again. It was called "Communications Sets Its Sights Ahead," and in it Harold Osborne shared his vision of communications as it would evolve in the near term and in the long run. Electronic switching, transcontinental waveguides, ocean cables, and person-to-person television all were a part of his vision. And all were set forth soberly, rationally, in terms appropriate to the dignity of a chief engineer. His final prediction, in the last two lines of his dissertation, struck a somewhat different note, however. "I predict with full confidence," he wrote, "Gentle reader, you ain't seen nothing yet."

In closing let me say as one who has known Harold Osborne for many years and who has had occasion to appreciate his impatience with idleness: Gentle listener, you may think Harold Osborne has retired, but I predict with full confidence, "You ain't seen nothing yet!"

Response of the Medalist

H. S. OSBORNE
FELLOW AIEE

IN RECEIVING this outstanding honor I have a feeling of great pride and also of humility. This is a natural reaction to having one's name associated in this way with the great name of Edison, and with the long list of very distinguished men to whom heretofore the Edison Medal has been awarded. Mr. N. S. Hibshman's letter telling of this award reached me when I was nearly as far from New York as one can get on the surface of our little planet. I had no intimations of the imminence of eminence. You will note that in spite of my surprise, I accept the award quickly and firmly. And I do so with profound gratitude to the Institute for such extremely handsome recognition of my work.

In his generous introduction, Mr. Romnes modestly omitted mention of one item of which I am proud. This is the fact that I provided much of the training and opportunity for the development of the young man Romnes. I was delighted that he was chosen to be my successor at AT&T and that from that position he moved on rapidly to other responsibilities.

The Edison Medalist not only receives a very great honor and a beautiful piece of gold but has the privilege of talking to this meeting of fellow members of the AIEE. I find in earlier papers some precedent for what I wish to do. That is, not to try to say anything new, but direct your thoughts to some old subjects which seem to be important today.

In the year 1844 the United States Commissioner of Patents said, "The advancement of the arts from year to year taxes our credulity and seems to presage the arrival of that period when human improvement must end." And 42 years later the Commissioner of Labor made his famous report to the effect that industry had been fully built. "It is true," he said, "that the discovery of new processes of manufacture will undoubtedly continue, and this will act as an ameliorating influence, but it will not leave room for a marked

H. S. Osborne, past president AIEE 1942, was formerly chief engineer, American Telephone & Telegraph Company, New York, N.Y.

extension, such as has been witnessed during the last 50 years . . ."

What a mistake they made! But I think it is interesting that even 100 years ago the rate of technical and industrial development seemed so fast that it could not continue. Whereas, in fact, instead of stopping, it has accelerated so much that we now are really in an explosive age.

TELECOMMUNICATIONS

THE ART of telecommunications illustrates this explosion. Decade by decade, there have been repeated radical improvements in techniques. These have brought about expansions of the scope and amount of service far beyond earlier dreams. When the telephone system was far smaller than it is now, we used to talk about saturation of telephone service. Today, with 73 million telephones in service in the United States alone, I don't know if the word "saturation" is even in the dictionary.

It would be easy to suppose that, in view of the tremendous technical advances of the past 50 years, the art of telecommunications is now mature, subject, to be sure, to future minor improvements, but not to radical changes.

How wrong this assumption would be! This Winter Meeting of the AIEE alone includes 13 sessions devoted to improvements in telecommunications techniques and, in addition, 21 sessions on closely related matters, including the design of apparatus used primarily in communications. These are the numbers of sessions, not of papers.

Consider for a moment some of the impending radical developments in telephony. Today we have automatic switching systems which, in response to the customer's dial, make connections quickly and efficiently even across the continent. These systems use electromagnetic switches. Now we have emerging a fully electronic system much more sophisticated than those heretofore in use. It will give the telephone user a lot of service features not now practicable. To name just one, each subscriber can be given his own special 2-digit codes for the telephones he calls most frequently. The machine will instantly translate these special codes into the national numbering plan and complete the connection.

In long distance telephony today we have broadband transmission channels, both by wire and by radio, each one of which carries hundreds of telephone circuits, or a single television signal. Now we have the prospect of long distance waveguides which will transmit very much higher frequencies than can be used in the open air. The waveguide will provide its own atmosphere and avoid the limitations of atmospheric absorption. It will use novel modes of wave propagation. With such a system, it is expected to transmit frequencies of 100,000 mc with transmission bands so broad that one band can carry 200,000 telephone circuits or 200 television transmissions.

Overseas telephony is an interesting special case where development heretofore has been greatly hampered by technical difficulties. For years it was dependent on short-wave radio. A great deal was done to make maximum use of the radio spectrum. Nevertheless, there was no way to provide either the capacity or the quality required to take care of service needs.

A great breakthrough came with the development of electronic amplifiers which could be built into deep sea cables and would operate for many years without attention at the bottom of the ocean. The first pair of cables so equipped, completed in 1956 between the United States and England, have had their capacity increased to the amazing total of 84 telephone circuits by very ingenious developments of terminal equipment. Other cables are being placed. Nevertheless, there is a great need for many more circuits and for lower costs.

Now we enter the era of possible world-wide communications through the use of satellites as relay points. The success of the experiments with Echo I in transcontinental and trans-Atlantic transmission indicates that this can be done. Bell System engineers estimate that 50 satellites in polar orbit will give continuous communication channels in large numbers between any two points in the world. Such channels would provide also for television transmission throughout the world.

I want to mention one other illustration of the rapid change in telecommunications. I refer to direct communication between machines talking to each other in their own language. This form of telecommunications avoids the redundancy inherent in the use of the written or spoken word, and so speeds up the transfer of information. It holds promise of becoming a very big part of telecommunications in the future.

This picture of a continuing rapid change in telecommunications is illustrative of what is going on in many fields of technical development. Consider, for example, transportation. In rapid succession come the railroad, the automobile, the propeller airplane, the jet airplane, supersonic jets in commercial as well as military use, the space vehicle.

The list could be greatly extended. I need mention only a few: the generation of power, the transformation of power from one form to another, the automatic control of industrial and manufacturing processes, the creation of new materials.

Back of all this is the accelerating expansion of scientific knowledge. Dr. Alan Waterman, of the National Science Foundation, said here a month ago that the decade ahead is certain to bring further important science breakthroughs in a number of significant fields, and some of these discoveries may pose major problems for the human race.

AN EXPLOSIVE AGE

YES, this is well called an explosive age. The explosion is not only in science and technique, but, because of them, in man's social environment and political institutions. The prospect is bewildering and inspiring, perhaps frightening.

As engineers we are contributing much to the rising

sea of physical changes. What should we do about the revolutionary social changes which result? There is a school of thought which says that the engineer, because of his training and abilities, is better able than anyone else to cure the ills of the world. I do not myself adhere to that school of thought. Let us hope that as an individual the engineer will fully do his share as a citizen. If in some cases he can bring to public questions more than average understanding, he has that much more responsibility to take an active part in public affairs. I should like to leave this broad question with that general comment.

I think, however, it is useful to discuss briefly what we as an organized group of engineers should do in recognition of our exploding environment. I can discuss this without apology at a meeting of the American Institute of Electrical Engineers. The question has been before the Institute continuously and actively in many ways for a long period of years. The Institute has indeed been leader in promoting such discussion.

The Institute has not only discussed, but acted. The President and other officers, the Board of Directors, and the appropriate committees have given increasing attention to adjustment of the Institute's program and organization to meet its professional responsibilities under changing conditions. We may feel proud of the flexibility which the Institute has shown.

One important change in conditions is the disintegration of the lines which have separated the traditional branches of engineering. Both Past President Foote, a year ago, and recently President Linder have spoken of this fact and the reaction which it has on the activities of the engineering societies. It puts an increased urgency on their studies of intersociety cooperation, and of the organization of the profession as a whole.

There is another aspect of the present situation which I believe deserves special emphasis. That is the responsibility which the engineering profession and its societies have for service to the public. It has been pointed out that the thing which distinguishes a profession from a nonprofessional group is a sense of responsibility on the part of the members of the profession to use their specialized knowledge for the benefit of the public. As Dr. Vannevar Bush has put it, "There has been no true profession that has not with dignity and authority advised and counseled the people, that has not guarded the commonweal."

In the eyes of the public, the professional stature of the engineer and of his organization will, in the long run, be determined largely by this criterion.

We are all conscious of the fact that the most effective discharge of our public responsibilities as a profession often requires action by the profession as a whole, not independent action by a number of engineering societies. Recognition of this has been a prime stimulus for the extensive work which has been done seeking for means to bring about a greater unity of the engineering profession.

For a number of years many engineering societies have taken part in this quest. Some progress has been made. Engineering societies are working together in a number of ways. I think, however, that most engineers agree that more needs to be done. We do not think that the present co-operative arrangements between engineering societies provide the degree of unity which the profession should seek. And we do not find in them an adequate basis for advising and counseling the people authoritatively and with the collective wisdom of the entire profession. These views are strengthened when we look not at the past, but at a future of accelerating change.

UNITY OF THE PROFESSION

THE DISCUSSIONS OF UNITY of the engineering profession have centered about a consideration of the relative advantages of a number of different proposed forms of organization. There has been no general agreement on these relative advantages. I do not propose to discuss them today. What I am saying is neither in support of, nor in opposition to, any of the proposals which have been advanced.

I do wish, however, to make one concrete suggestion, in the hope that it may be helpful.

It seems to me the lack of agreement regarding the form of organization of the profession is due at least in part to differences in view as to the aims which the profession should hope to achieve. Might not additional progress be made if the leaders of the profession would undertake jointly to crystallize a clear statement of the purposes for which the profession should aim in deciding upon its future organization? There are many facets of this question, and they all should be considered. I suggest, however, that particular attention be given to expressing what goals related to its public responsibilities the profession should seek to achieve. In their deliberations the leaders would fully take into account the explosive character of our era, both technically and socially. They would, I hope, study the question in its full breadth and depth. And they would consider the problem in its long-range aspects, as well as in the light of conditions of today.

If representatives of our great engineering societies should work out together such a basic statement of aims, I believe it would help greatly in reaching agreement on the forms of organization which are best designed to accomplish these aims.

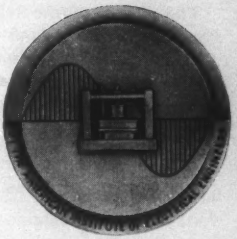
In this discussion I have tried to picture the background against which I feel that a greater unity of the engineering profession is of increasing importance and urgency. I believe that the clear expression of high purposes and the recommendation by the leaders in the profession of an organization to achieve those purposes will inspire the general and enthusiastic support of engineers in all branches of the engineering profession.

So organized and so inspired, the engineering profession can build a place for itself, even greater than it occupies today, in the life of our country and in the esteem of its people.

Mervin J. Kelly

1960 Mervin J. Kelly Medalist

" . . . for outstanding contributions in the technology of telecommunication; as a distinguished organizer and an eminent leader."



FOREWORD

S. R. WARREN, JR.
FELLOW AIEE

By agreement between the Bell Telephone Laboratories and AIEE, the Mervin J. Kelly Award—a bronze medal, a certificate, and $1,000—may be made each year to an individual or group of individuals for outstanding contributions to the "advancement of the art of telecommunications."

When the AIEE Recognition Awards Committee examined the data on nominees for the Kelly Award, it became quite clear, first, that several of the nominees were outstandingly eligible, and, second, that one of them, Dr. Kelly, was unique in the depth and breadth of his contributions to telecommunications. It was recognized that the selection of Dr. Kelly for the first award established to honor his name might be a source of embarrassment to him and to the sponsors of the Award. The Committee proceeded in a manner which I am sure you will agree is in accord with its responsible charge: it selected Dr. Kelly because his work is judged pre-eminent among all of the excellent candidates for the Kelly Award for 1960.

First, there is the solid and original scientific foundation of Dr. Kelly's career. His formal education led to the degree Ph.D. in physics at the University of Chicago where he worked with R. A. Millikan on the famous "oil-drop" experiment. As physicist for the Western Electric Company, he contributed to the solutions of several fundamental physical problems. In particular, he played a key role in the development of the extremely stable vacuum tubes produced by the Western Electric Company, and in pioneering the development of high-powered, water-cooled vacuum tubes.

The second point of emphasis is the breadth of Dr. Kelly's activities. He has been and is a scientist, engineer, executive, and public servant. It is difficult to find a professional area to which he has not contributed.

For example, I recently received a newsletter of the Society for the History of Technology, a very successful young society. Dr. Kelly is not only the first vice-president of this society; he has worked with another member to lead a very successful membership drive.

Finally, and perhaps most important, there is the man himself. Those privileged to have worked with him attest to his personal warmth and sympathy, his humility, and his stimulating leadership.

It can be reasonably inferred that Dr. Kelly is a very energetic man; most men would be hard pressed to carry on even a fraction of his activities. Yet he finds time each year to "ride" his favorite hobby—flower gardening. An acre and a half of land at his home produces a profusion of blooms from March to December.

Before presenting Dr. Kelly to President Linder, I should like to read to you a telegram addressed to Dr. Kelly in care of Nelson Hibshman, Executive Secretary of AIEE:

> "In the knowledge of the magnitude of your contributions to your country as well as to your own field during a long and distinguished career, I am very pleased to extend my congratulations to you for the honor you are receiving today. Your leadership of the Bell Telephone Laboratories and your many Washington assignments have resulted in major contributions to the nation's defense effort. At least of equal importance has been the significance of your activities in applied science education, your work to strengthen the conduct and competence of science in the federal government, and your success in raising the pro-

Address of acceptance made at the ceremony of the Mervin J. Kelly Award in Telecommunications during the AIEE Winter General Meeting, New York, N. Y., Jan. 29-Feb. 3, 1961.

S. R. Warren, Jr. is assistant vice-president, undergraduate engineering affairs, University of Pennsylvania, Philadelphia, Pa.

fessional standards in engineering. The award being presented to you today by the AIEE not only honors you directly for these and other contributions, but by virtue of being established in your name as an annual award, sets your standards of excellence and accomplishment as a goal for others of your profession."

The signer of the telegram is John F. Kennedy, President of the United States.

Mr. President, I have the honor to present to you for the Mervin J. Kelly Award its first recipient, Dr. Kelly, who is cited:

"For outstanding contributions in the technology of telecommunications; as a distinguished organizer and an eminent leader."

Response of the Medalist

MERVIN J. KELLY
FELLOW AIEE

DURING the last 20 years of my service at the Bell Telephone Laboratories, my participation in its broad spectrum of programs dedicated to the advancement of the art of telecommunications was as a leader, organizer and co-ordinator. It is with this background of experience that I present views on the current status of the nation's research and development.

The past 20 years are among the most fateful in the human record. They encompass the initial period of the continuing world struggle for the maintenance of the dignity and freedom of the individual. In this contest the relative military and economic strengths of the free and communist societies may well determine the ultimate outcome. These strengths are primarily dependent on science and technology. As the leader of the free societies in this contest, our nation's strength in science and technology is of primary importance. Its research and development are the source of its strength in science and technology.

The tremendous rate of expansion of the research and development effort in these past 20 years provides ample evidence of our recognition of its importance. As measured in constant dollars, it has increased fifteenfold from $800 million in 1940 to $12.5 billion in 1960. In the same period, the gross national product has increased only threefold, and the population 1.3-fold. While significant progress has been made in raising the effectiveness level of the national program, particularly since Sputnik, it is still far below the level attainable—that limited only by the innate capacities of our people. It is of measures that are essential to progress toward this goal that I will speak.

Mervin J. Kelly at his retirement in 1959 was chairman of the board, Bell Telephone Laboratories.

BASIC RESEARCH EFFORT INADEQUATE

THE PORTION of the nation's research and development effort devoted to fundamental or basic research is too small. While no agreed-upon sharp line separates basic and applied research, it is generally accepted that less than 10% of the nation's expenditures is for basic research. Its level should be doubled as rapidly as the required scientists can be trained. Industry, which does at least 70% of the research and development, performs less than one fourth of the basic research. In the interest of not only national strength but also of each corporation's strength, corporate volume should be increased threefold as that of the nation's is doubled. At present, a large fraction of the basic research of industry is done by some 15 to 20 of the larger corporations. Every industry with a staff of 100 or more in its development laboratory should participate in basic research. This would not only add to the nation's total, it would also strengthen each laboratory and make their development programs more effective.

The nation's situation in the materials area is a striking example of the effects of inadequate basic research. Highly refractory metals that will withstand the very high temperatures demanded in the missile and space age have been urgently required. In the absence of the knowledge that would only be available through an adequate level of basic research, a huge development effort has been made—much of it empirically based—and yet our requirements have not been met.

The development area, which includes systems engineering, exploratory development, and specific development and design, is predominately staffed with engineers and scientists whose training in mathematics and the sciences is inadequate in depth. At least 80% of the young scientists and engineers currently entering the nation's laboratories are trained to the bachelor level. The total laboratory population has still a larger percentage with only this level of training.

TRAINING IN BASIC SCIENCES DEFICIENT

AS OUR UNDERSTANDING of nature's matter and energies has become deeper and more exact, and as the facilities to meet the peaceful and defense needs of our society have become more complex and rigorous in their requirements, the creation of new facilities demands evermore analytical, exact, and scientific procedures. Empirical, qualitative development procedures all too common at present, are not only wasteful but too often do not realize facilities that the forefronts of science and basic technology make possible.

The facilities needed today and the scientific knowledge for their fulfillment demand that the nation's professional development staff have deeper training in mathematics and science than at present. As measured in years of academic training, at least one fourth of those in development should have the equivalent of a doctorate training, one half should have that of a master's and only one fourth should have that of a bachelor's, in contrast with the present three fourths at the

bachelor level and only one fourth with more advanced training.

I have stressed the inadequacy of the present training pattern for scientists and engineers for the nation's creative technology. Second to this deficiency in importance is that of the number of scientists and engineers who are being trained. With a fifteenfold increase in research and development in the past 20 years, there has been less than a fourfold increase in those completing their academic training each year in the sciences and engineering. For the past few years, the freshman class in engineering has stayed at about the same level.

While the deficiencies of the nation's training program are perhaps known only to those of our profession, the growing inadequacy in number is clearly discernible to the "man in the street." A Sunday issue of the *New York Times*, for example, often carries more than 10 pages of advertisements for scientists and engineers placed by the nation's industries. The daily papers of two relatively small cities that I frequently visit often carry advertisements for scientists and engineers with the special backgrounds of training and experience of the members of laboratories in those two cities. All that is accomplished, as seen from the national viewpoint, is the shift of personnel from one place of need to another. The national inadequacy remains unchanged.

For the correction of the inadequacies of quality and quantity in the nation's research and development staffing, we must look to improvements in our educational system and enlargement of its financial support. Activities directed toward improvement are most encouraging, even though inadequate. To view areas where added emphasis and support must be given, I will present a condensed appraisal of the status of the present constructive effort.

SPECTRUM OF EDUCATION UNDER SCRUTINY

To increase the number choosing science or engineering as careers and to deepen their training, the spectrum of education from the secondary school through high school and the undergraduate university has been under critical scrutiny followed by constructive action. The programs are comprehensive, basically sound, and are already yielding encouraging results in many areas. They must be extended to national coverage.

The nation's secondary and high school training in mathematics and science has undergone progressive deterioration through the past 40 years. This has been primarily due to misplaced emphasis on methods of teaching at the expense of content in the nation's schools of education where our secondary and high school teachers are trained. This has developed a generation of teachers of science and mathematics for our precollege education that are inadequately trained and largely unaware of the philosophy and new knowledge at the frontiers of science. The almost total neglect of science and mathematics education at the secondary and high school levels by the academicians at the forefront of science and mathematics has made a contribution to this tragic situation.

With the financial support of the National Science Foundation, the Ford and Sloan Foundations, and several industrial corporations, this major deficiency has been attacked on a broad front. Summer institutes in many universities and technical schools are now training the teachers of our precollege schools. Early morning television courses in science and mathematics for teachers are given on a national basis. All of this with subject matter provided by forefront scientists and mathematicians. New text books and laboratory manuals in physics, chemistry, biology, and mathematics are in different states of preparation by groups of university professors in association with high school teachers.

The physics program was initiated at Massachusetts Institute of Technology (MIT) in 1956 under the imaginative leadership of Prof. J. R. Zacharias. Its text and laboratory manual have been completed and are already used in 1,200 high schools. The other programs are well along. Soon we shall have excellent, modern, challenging high school texts in the sciences and mathematics, and teachers that are adequately trained for the instruction.

Sponsored by the Carnegie Foundation, Dr. J. B. Conant made a study of the high and junior high schools of the country and prepared recommendations for their improvement. This study with recommendation for action, couched in language that school boards can comprehend, will make constructive contribution to structure, organization, and procedures for our high and junior high schools.

Much has been accomplished at the secondary and high school levels since Sputnik, but much remains to be done.

NEW CURRICULA EVOLVING

Similar searching analyses of our undergraduate engineering and science curricula are in progress. In general, the engineering curricula were fashioned to prepare engineers for practice and application of established technology and not for participation in creating new technology. New curricula, with a much larger content of science and mathematics, are in evolution that will provide a better foundation for a career in creative technology. A pioneering effort in electrical engineering by Prof. G. S. Brown of MIT has established the general pattern of change. The Ford Foundation has made large grants to a few technical universities for extending this type of revision to curricula in all engineering branches.

When these curricula revisions at the precollege and college level are completed and in general use, our engineers and scientists at the bachelor level will have a depth of training in science and mathematics that will be some 2 years beyond that of the pre-Sputnik era. It is also hoped that the new approach to and added emphasis on science and mathematics in our secondary and high schools will bring about the tragically needed increase in the number of our youth who choose science and engineering careers.

There remains for discussion the nations' deficiencies

in basic research and training beyond the bachelor level in science and engineering. Our graduate schools of science, where more than half of the nation's basic research is done, are unsurpassed in the world. The training for the doctorate level is excellent. The single significant deficiency is in quantity—the number that we are training and the amount of basic research.

MOTIVATION TOWARDS DOCTORATE LEVEL

THE CONDITIONS in applied and engineering research and in graduate schools of engineering are identical with those in basic research and graduate schools of science. However, there is one important difference. Continuation of study to the doctorate level is the traditional national pattern in science. The ambition of the young science student is to continue to his doctorate. Beginning his career at the bachelor level is the traditional national pattern for the engineer. This is proper and largely adequate for the practice of existent technology. It is wholly inadequate for participation in creative technology. There is, therefore, the added problem in engineering of developing the desire for continuing to the doctorate level in our young engineering students of superior qualities and providing the incentives. At present, there are not adequate incentives to attract a sufficient number into graduate study.

The inadequate levels of research and of graduate students in science and engineering can only be corrected by greatly increased financial support of our graduate schools. New buildings and facilities are urgently needed. Compensation levels of the faculties must be increased. Larger numbers of graduate fellowships with higher levels of compensation are necessary if we are to attract the number the nation requires in our graduate schools. The attractive compensation levels of industry for the young bachelor of engineering are tempting too many to begin their careers after completing their 4-year course.

It should be noted that even with the present graduate school facilities much of the work is done in overcrowded, obsolete buildings and with less than adequate modern equipment. Until the nation provides housing, facilities, and environment in our graduate schools of science and engineering and compensation for their faculties competitive with that now current in our major industrial research and development laboratories, the national deficiency in research and in scientists and engineers trained to the doctorate level will persist.

It is my considered judgment that the rapid elimination of the deficiences in our educational system that I have sketched is essential for our nation's maintaining its number one position in world strength. For this, largely increased financial support at all levels of the education system, from the secondary schools through the graduate schools, must be had. Our nation has the resources; I believe that with understanding, it will have the will. All of us in science and engineering possessing this understanding have a mission—a special responsibility—to spread this understanding throughout our society.

The commencement of a new national administration, pledged to New Frontiers and the preservation of the dignity and freedom of the individual, provides a most opportune time for our rededication to this mission.

Improved Money Changer

Improved money changer for 10-cent vending machines has been developed by the ABT Division of Automatic Canteen Company of America. The unit, called the model *6000*, activates the vending electrical system upon the insertion of a dime, two nickels, or one quarter. When a quarter is inserted, it pays out a dime and a nickel in change, or can be set to pay out three nickels in change. Change coin tubes *(lower right)* are filled automatically by nickels and dimes paid into the changer. The dime tube provides vending operators with the advantage of a larger coin reserve—three times that of a nickels-only payout. Increasing the proportion of dime payouts also invites more dime vending sales, according to ABT management. When these self-locking tubes are full, incoming dimes and nickels are directed into the vending machine's cash box. When the tubes are empty, the unit rejects quarters.

The unit is shown here in combination with ABT's model *4000* slug rejector *(top)* which validates United States coins and rejects all slugs and foreign coins.

The Effect of Contact Synchronization on A-C Interruption

A. M. HOWATSON

An investigation has been conducted to determine the dependence of interrupting performance of a-c circuit breakers upon the timing of contact separation. Test procedures, circuits, and results are described in this article.

IN AN A-C circuit breaker, the chance of extinction for a given transient recovery voltage waveform depends on the rate at which the arc gap tends to deionize following current zero. This rate of dielectric recovery must depend upon the gap conditions at current zero, and for a given peak current these conditions depend only on the previous duration of arcing; that is, on the instant of contact separation relative to the current cycle. It has already been established that when contact separation is timed to occur shortly before current zero, the performance of a large circuit breaker can be improved.[1]

A qualitative argument readily shows the possibility of an optimum instant of separation for contacts opening at normal speeds. For short arc durations, the energy in the gap when current zero is reached is small, favoring extinction; but the gap length is also small, making breakdown more likely. Conversely, longer times imply more energy but a longer gap. Since the effects of energy and length are in opposition, it is conceivable that for some point of separation the reignition voltage at a given instant after current zero will be a maximum, and that the probability of successful interruption will be correspondingly improved. This article describes an investigation of the dependence of interrupting performance on the timing of contact separation.

EMPIRICAL ANALYSIS

ALTHOUGH mathematical models for the arc in the current zero region have been developed by Browne[2] and others, the theoretical derivation of reignition voltage curves is extremely difficult. Experimentally, such curves have been obtained for free recovery following a rectangular pulse of current between fixed electrodes.[3] Cobine and others[4] have described apparatus for studying free recovery under power system conditions, using a half-sinusoid current pulse; but again the initial conditions are fixed. However, it is possible to estimate the effect of varying arc energy and arc length by making certain assumptions.

The form of characteristic usually attained in free recovery studies is nearly exponential. The reignition voltage may then be written

$$V = V_0 (1 - \epsilon^{-at})$$

where V_0 is the final breakdown voltage of the gap, t the time from current zero and a a constant depending on the rate of deionization. Assuming that breakdown voltage is proportional to the gap length l, and that the arc energy W affects the rate of recovery adversely, then the simplest expression for V is of the form

$$V \propto l (1 - \epsilon^{-\alpha l/W})$$

where α is a new constant.

To allow for a finite arc voltage at $t = 0$, a term in l_0, the gap length at current zero, may be introduced, giving finally

$$V = Al_0 + Bl (1 - \epsilon^{-\alpha l/W})$$

where A and B are constants.

The variation of l may usually be assumed to lie between the cases of constant velocity, $l \propto t$, and constant acceration, $l \propto t^2$. The arc energy is obtained by integrating the input power over the arc duration angle θ. If the arc voltage per unit length has a constant value v during the major part of any half cycle, then

$$W = vI_{\max} \int_0^{\theta/\omega} l \sin (\omega t - s)\, dt$$

where $I_{\max}$ is the peak current and ω the angular frequency. This expression is easily evaluated for the chosen form of l in terms of θ and the various constants.

Fig. 1 shows the resulting curves, for the two cases of constant acceleration and constant velocity, for reignition voltage at particular instants as a function of θ. The maxima indicate that there is an optimum value of θ for a given peak current and recovery voltage transient.

The foregoing treatment neglects dissipation, which would have the effect of flattening the curves and, therefore, applies only for limited values of arc duration. Hence, only the first current zero is of interest, for, apart from the limitations of contact movement, steady-state conditions are likely to apply at subsequent zeros.

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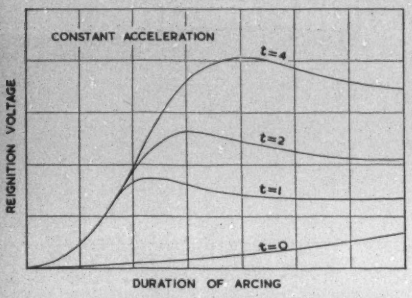
The author gratefully acknowledges the award of an Associated Electrical Industries Fellowship in the University of Cambridge, during the tenure of which this work was done. He also thanks Prof. C. W. Oatley for his assistance.



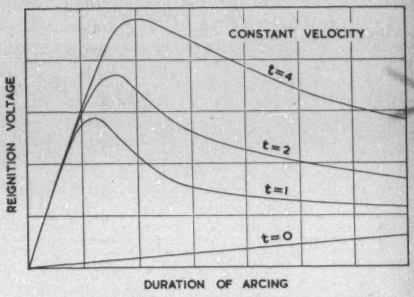


Fig. 1. Dielectric recovery (t in arbitrary units).

LABORATORY INVESTIGATION

The Circuit Breaker. Fig. 2 shows the experimental circuit breaker used for the investigation. The contacts, of ½-inch-diameter copper tube with replaceable copper tips, move in a rigid framework and are open to atmosphere. The lower contact is actuated by the main compression spring and is held in the closed position by a toggle linkage. The top contact moves only sufficiently to maintain good connection until the other has the required initial velocity. By choosing suitable springs and varying the degree of loading, a good approximation to constant velocity or constant acceleration may be obtained. An oil dashpot arrests the lower contact when the gap is 2½ inches long.

Synchronization is effected by timing the impulse to a solenoid, the plunger of which releases the toggle.

Test Circuit and Operation. Fig. 3 shows the circuit used for testing and recording. Iron-cored adjustable reactors limit the current from a 360-volt 50-cycle source, which is connected to the breaker through two poles of a 3-phase contactor. The third pole acts as a holding contact. When the contactor is closed, auxiliary contacts initiate the test sequence. Seven seconds elapse before the timing unit provides a pulse, related in phase to the supply current, which triggers the operating solenoid through a thyratron, and the time bases through a variable delay. The required phase relationship is selected by a rotary phase shifter.

Voltage across the gap can be recorded on two different scales from a 40-kilohm potential divider, and current from a 0.1-ohm series resistance, also on two scales. For recording contact travel, an arm on the lower contact picks off a voltage from a uniform resistance winding, the current in which is held constant by a pentode.

A bank of cathode-ray tubes with independent time bases enables all required quantities to be recorded simultaneously; time calibration is provided by the oscillator during a second sweep which can be triggered by the "test" button.

RESULTS

Accuracy of Synchronization. It was not possible to select angles of arc duration without previous trial, because of the time delay inherent in the tripping mechanism and nonlinearity in the phase shifter. Once the unit was calibrated for a particular spring setting, consistency achieved was satisfactory and seemed to improve with time. The angle of arc duration up to first current zero was measured from the oscillograms of arc voltage. Over a period of days, 18 tests at one phase setting had a mean angle, measured in this way, of 26 degrees, a maximum error of 4 degrees, and a standard er-

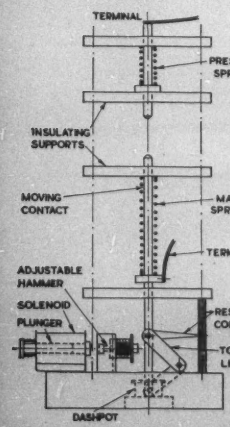


Fig. 2. Experimental circuit breaker.

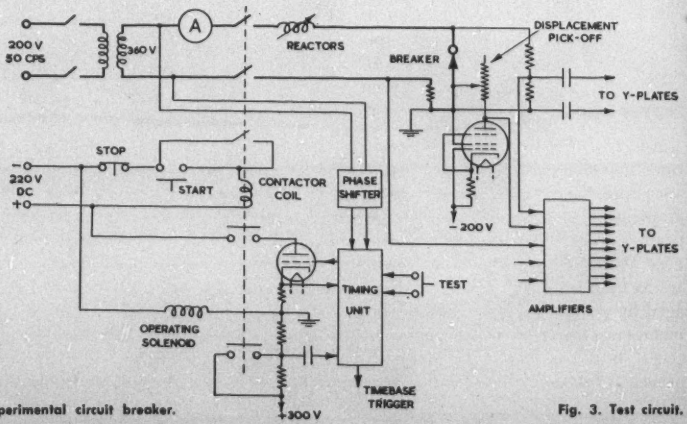


Fig. 3. Test circuit.

ror of 1.3 degrees. At another setting, for 18 tests the mean angle was 65 degrees, the maximum error 3 degrees, and the standard error 1.4 degrees.

The time elapsing between the pulse to the thyratron and contact separation was between 8 and 11 milliseconds, depending on the spring setting. Since an error of 4 degrees represents 0.22 millisecond, the inherent delay was consistent to within 3%.

Because the operating pulse was derived from the voltage, not the current, of the operating circuit, the synchronization was affected by power factor. This gave little trouble, since the circuit remained unchanged for long periods.

Probability of First-Zero Interruption. To measure the interrupting performance as a function of arc-duration angle, the probability of successful interruption at first current zero was found from the oscillograms of a large number of tests at various phase settings. This probability at an angle θ was taken simply as the ratio of successes to total tests in a range of, usually, ± 10 degrees about θ. The density of tests varied, but six tests per interval was regarded as a desirable minimum. When the density was less than this, the graphs became too peaky.

Tests were made under various conditions of rms current I, shunt capacitance C, and contact movement. With no capacitor connected across the gap, and the reactors adjusted for 45 amperes, the natural frequency of the test circuit was 33 kc, and the rate of rise of recovery voltage 18 volts per microsecond. The addition of a 0.004-microfarad capacitor reduced these figures to 14 kc and 11 volts per microsecond, respectively, although the transient voltage peak was greater because of the reduced damping effect of the potential divider.

The probability graphs resulting from the test records are shown in Figs. 4 through 8, of which Figs. 4, 5, and 7 relate to tests at constant velocity. It is clear from Fig. 4 that first-zero interruption at 25 amperes is comparafects of energy and length are in opposition, it is consmall arc durations. Only at 35 amperes does the rate of rise of recovery voltage have a pronounced effect, the performance being much better with no shunt capacitance added. This can be explained by the lower peak transient voltage being more important than the increased rate of rise at this current. At 45 amperes, where reignition may take place at lower voltages, there is slightly better performance with a reduced rate of rise.

Effect of Velocity. Fig. 5 shows that an increase of opening velocity does not improve the breaker performance appreciably. On the contrary, comparison with the graph of Fig. 4 with $C = 0.004$ microfarad at 35 amperes indicates an over-all deterioration. This, however, is most likely due to a growing tendency for the arc to flash over to parts of the breaker frame, encouraged by gradual carbonization of some of the insulating members. Graph A is based on a complete series of tests; graph B is based only on those tests made after improved insulation of the frame, and shows a distinctly better performance.

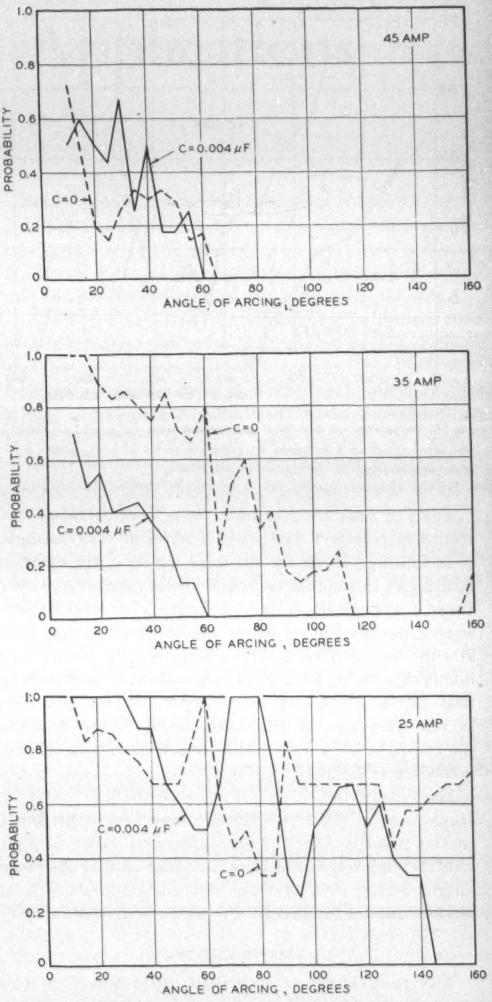


Fig. 4. Probability of first-zero interruption, with opening velocity of 80 inches per second.

The results obtained using 0.008 microfarad across the gap show that further reduction in rate of rise of recovery voltage has a much greater effect than has the opening velocity.

Optimum Timing. None of the tests at constant velocity showed any significant maximum of probability for angles down to 10 degrees. The curves of Fig. 1 show that such a maximum should occur at larger angles in the case of constant acceleration than in the case of constant velocity. Attention was given, therefore, to the former for investigating the optimum condition. The results are shown in Fig. 6. There is a definite probability maximum at 8 to 9 degrees.

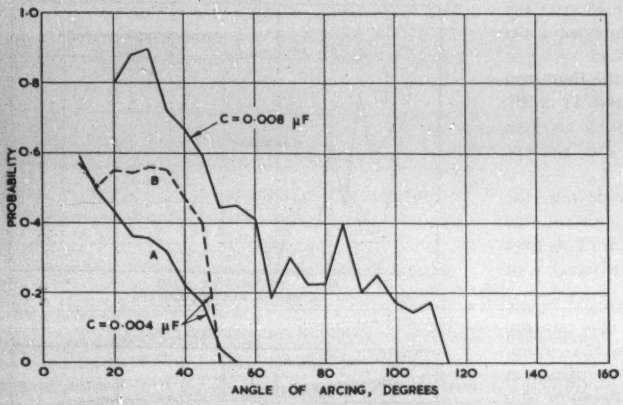


Fig. 5. Probability of first-zero interruption with an opening velocity equal to 100 inches per second. Graph A is based on complete series of tests; graph B is based on tests made after improvement in insulation of the frame.

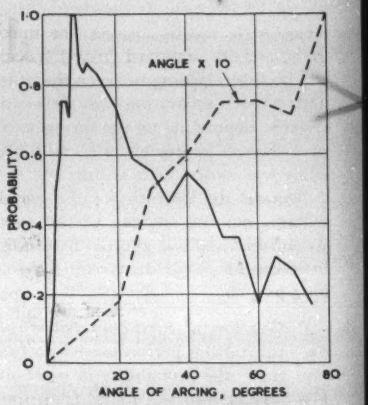


Fig. 6. Probability of first-zero interruption, with opening acceleration of about 22,000 inches per second^2. C = 0.004 microfarad.

Effect of Polarity. Normally, tests were balanced with regard to polarity; six tests of a series at various angles were followed by six for the same angles in the opposite half cycle. Individual records showed no obvious difference, but statistically it was found that probabilities were generally higher where the top contact was initially the anode. This is surprising, since the future cathode is then being heated by convection. It may indicate that the anode has a more important role than expected. The effect is illustrated in Figs. 7 and 8, where the results of Figs. 5 (graph A) and 6 have been divided according to polarity.

Most of the test series started with the top contact as anode, so the effect of sequence may have contributed to the polarity effect. There appeared to be a slight tendency for reignition to occur more readily after prolonged arcing in a previous test, although there is no obvious reason for this in the present circumstances.

CONCLUSIONS

THE PROBABILITY of successful interruption of alternating current at the first current zero following contact separation is a function of the angle of arc duration. This function has a maximum at 8 to 9 degrees for one set of conditions in the breaker investigated. The existence of this optimum angle is in accord with deductions made on an empirical basis. It may be expected that an optimum exists under most conditions, and in most circuit breakers, but the angle may be quite small. In general, the results suggest that the timing of contact separation can greatly improve interrupting performance. The velocity of separation appears to be much less important than the rate of rise of recovery voltage as a parameter.

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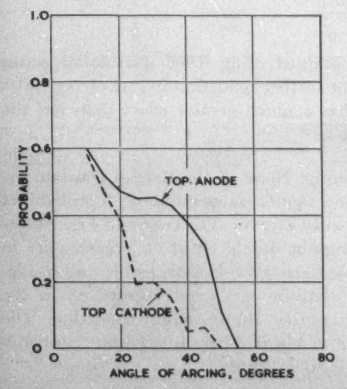
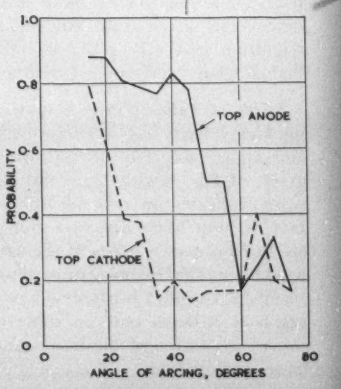


Fig. 7 *(left)*. Effect of polarity tests of Fig. 5, graph A. Fig. 8 *(right)*. Effect of polarity tests of Fig. 6.



Tunnel Diode Applications

C. D. TODD

Tunnel diodes may be used to amplify, switch, or generate oscillations and can be combined with transistors to take advantage of favorable features of both devices. The tunnel diodes' basic circuit simplicity, high-speed operation, and various methods of combining them with transistors are illustrated and described.

THE tunnel diode was announced by Dr. Leo Esaki in 1958.[1, 2] As described, the tunnel diode is a single p-n junction which displays a negative resistance in the forward biased characteristic curve. Its primary mechanism of operation is quantum mechanical tunneling of electrons through the p-n junction. This action occurs approximately at the speed of light. Operation is thus possible in a frequency range far in excess of that for which the usual transistors may be used.

NEGATIVE RESISTANCE

NEGATIVE RESISTANCE devices are far from new. Many devices exhibit negative resistance, that is, decreasing current for an increasing voltage, in some region of their voltage-current characteristic curve. It is customary to divide negative resistance devices into two major classes, referred to as *N*-type and *S*-type.

The *N*-type of negative resistance device has the characteristic shape of the curve shown in Fig. 1. Note that for a range of voltage values between peak voltage, V_P, and a valley voltage, V_V, three current values are possible for each value of applied voltage. If the current is specified, however, only one voltage may exist for that current. *N*-type characteristic devices are therefore said to be current stable or open-circuit stable.

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Some typical devices which have an *N*-type characteristic are the gaseous discharge tube, the common base configuration of the point-contact transistor using the emitter-base terminals, the silicon unijunction transistor and the p-n-p-n switch.

The *S*-type negative resistance device exhibits a characteristic curve similar to that shown in Fig. 2. Note that for this device, there is a range of current values between a valley current I_V, and a peak current I_P, for which three voltage values may exist. Specifying the voltage, however, defines the one and only one value of current which may exist. *S*-type negative resistance devices are therefore referred to as being voltage stable or short-circuit stable.

Typical devices having an *S*-type characteristic are the vacuum tube tetrode (as used in the dynatron oscillator), the point-contact transistor in the common emitter configuration using the base-emitter terminals, and now the tunnel diode.

N-type and *S*-type negative resistance devices are duals of each other and therefore the theorems of duality are useful in transferring the knowledge of operation or design procedure from one type of device to another. This is helpful since most engineers have had more experience in working with devices having an *N*-type characteristic than with *S*-type negative resistance devices such as the tunnel diode.

TUNNEL DIODE AMPLIFIER

FOR PURPOSES of illustration we can assume that the tunnel diode equivalent circuit is only negative resistance shunted by capacitance. A very simple amplifier circuit might be that shown in Fig. 3(a). Its equivalent circuit is shown in Fig. 3(b).

At the resonant frequency of the tank circuit consisting of the inductor L, the diode capacitance C_d, and the tuning capacitor C, the equivalent circuit simplifies to that shown in Fig. 3(c).

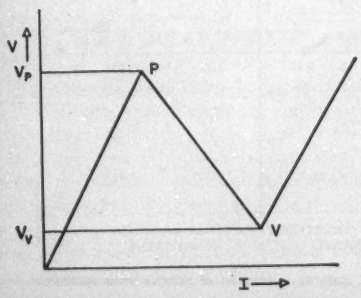


Fig. 1. (*left*) Voltage-current characteristic curve to an *N*-type negative resistance device.

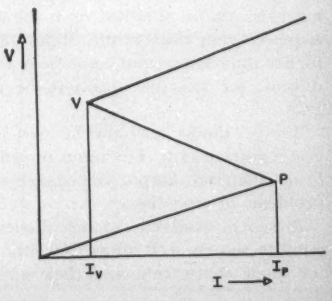


Fig. 2. (*right*) Voltage-current characteristic curve of an *S*-type negative resistance device.

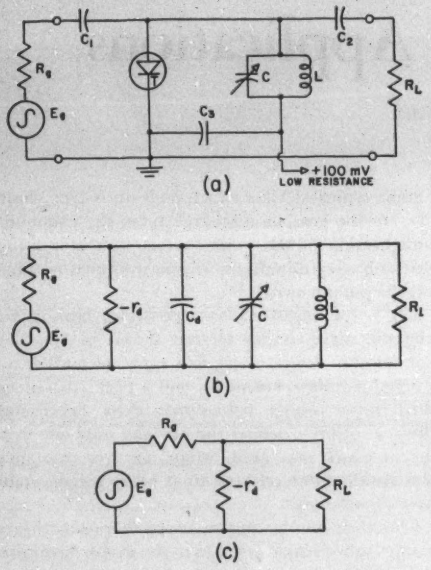


Fig. 3. (a) A tunnel diode amplifier and (b) its simplified a-c equivalent circuit, and (c) equivalent circuit at resonance.

The resulting power gain is given by the expression

$$G = \frac{1}{1 - \frac{R_L}{r_d}}$$

which is plotted in Fig. 4. Note that as the value of the load resistance approaches the magnitude of the diode negative resistance, the gain will become infinite. Unfortunately, this produces an oscillator rather than the desired amplifier.

If the load resistor is slightly higher than the diode negative resistance, a phase reversal would result in the output signal. An unwanted effect is that the input resistance is negative, resulting in instability.

Normally, the load resistor R_L is chosen to be slightly smaller than the magnitude of r_d, thus allowing the input resistance R_i to be positive with no resulting phase reversal.

The amplifier circuit described is an example of the use of the diode in the shunt or parallel mode. No voltage gain can be obtained from the application though a power gain does result. Input impedance is much higher than the output impedance thus making it very difficult for cascaded stages to be used for increased gain.

Tunnel diodes may also be used in a series mode to give a voltage gain. The input impedance will be much lower than the output impedance which will present problems in cascading.

Presently available tunnel diodes can be used to amplify signals well above 100 mc. As the technology for diode fabrication and their application advances, amplification in the kilomegacycle region will become feasible.

TUNNEL DIODE OSCILLATORS

As WITH MANY of the other negative resistance devices mentioned previously, there are two types of oscillations possible. If the operation of the diode is totally within the negative resistance region, the oscillation will be more or less sinusoidal at a frequency determined by the resonance of the capacitances and inductances involved.

If the operation is such that large signal switching occurs and action is not restricted to the negative resistance region, the result is referred to as a relaxation oscillator. More will be said about relaxation oscillation in the section on pulse circuits.

Coupling a negative resistance to a tank circuit in such a manner that the negative resistance is slightly more than adequate to compensate for circuit losses will produce oscillations which are more or less sinusoidal in nature.

A practical oscillator circuit might look very similar to that shown previously in Fig. 3 for the amplifier if the generator were omitted and the load resistance (including the shunt resistance representing the losses in the tuned circuit) were chosen to be slightly higher than the magnitude of the diode negative resistance.

Using very careful techniques, tunnel diode oscillators have been made which perform at frequencies in excess of 3,000 mc.

PULSE CIRCUITS

BY PROPER CHOICE of the load line, the tunnel diode may perform in a bistable, astable, or monostable mode, as shown in Fig. 5. Their high speed and lack of storage time certainly interest the designers of computers, but new techniques will be necessary before full use of their capabilities may be made. A major problem is one of isolation of the input and output circuits.

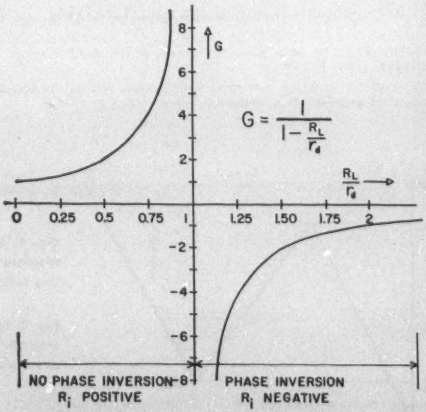


Fig. 4. Power gain as a function of relative load resistance.

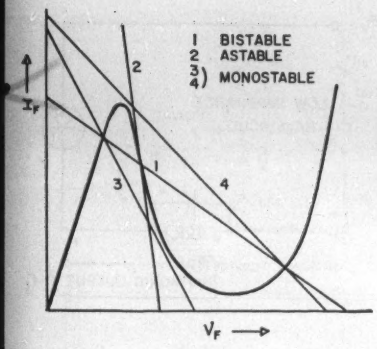
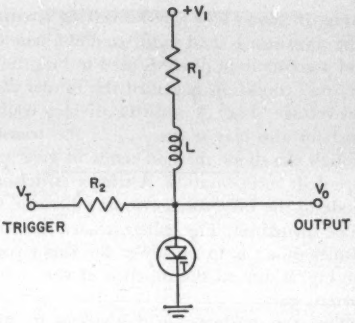


Fig. 5. (*left*) Biasing methods determine mode of operation.

Fig. 6. (*right*) The tunnel diode monostable circuit.



One approach presently being used by Dr. Goto of Tokyo University[3] is similar to that used in conjunction with Parametrons. This technique requires in effect a 3-phase square wave source to supply cascaded stages in a sequential manner.

One possible monostable circuit is shown in Fig. 6. Use of tunnel diodes in bistable circuits capable of cascade counting operation, while possible, presents difficulties due to a lack of complementary components such as diodes. The backward diode which has a very low breakdown voltage and operates on the tunneling principle is a possible solution to this problem.

By a slight change in operating point, the circuit shown in Fig. 6 for the monostable may be caused to assume an astable condition and a relaxation oscillation will be produced.

OTHER CIRCUITS

Converters. Tunnel diodes also may be used as r-f converters. A possible circuit is that shown in Fig. 7. A converter with some 20 to 30 db of gain should be possible.

Harmonic Generators. Because of their nonlinear characteristics tunnel diodes may be used for harmonic generation. A possible circuit for this function is shown in Fig. 8. The tunnel diode may also function as a modulator, a detector, or a d-c to a-c converter.

COMBINATIONS WITH TRANSISTORS

Simple Bistable Memory Elements. Because of their high speed, tunnel diodes operated in a bistable mode will respond to trigger pulses of extremely short duration. The output voltage level is quite low, however, making it somewhat difficult to use.

A transistor, on the other hand, operates at a much higher voltage level though its ability to respond to short trigger pulses is not as great as for the tunnel diode. Also, two transistors are normally required to achieve a bistable condition. A combination of the tunnel diode and the transistor in such a manner as to take advantage of the desirable features of both devices could prove most useful. Fig. 9 shows one method of accomplishing the desired result.

The supply voltage V_1 and the load resistor R_1 are chosen such that the load line intersects the composite d-c characteristic curve at two stable points.

If it is only desirable to have high-speed low-power triggering from one condition to the other with resetting accomplished by some other means (such as supply disconnect or a high-current reset pulse), then the load line might be that labeled "1" in Fig. 9 and both V_1 and V_2 may be the same supply and may be any voltage which will not exceed the maximum voltage ratings of the transistor.

A requirement that the circuit be capable of resetting from a low-power trigger of the opposite polarity demands the use of a load line similar to that labeled "2" in Fig. 9. V_1 in this case must be in the order of 500 millivolts though it may be derived from the V_2 supply by use of a low-resistance voltage divider.

The small inductor L placed between the tunnel diode and the base of the transistor serves to isolate the shunt capacitance and resistance of the transistor input from the triggering source, thus allowing higher speed triggering. Some slight ringing is possible but will normally be negligible.

As shown, the circuit of Fig. 9 removes the negative output voltage upon the appearance of a negative input pulse, thus producing an inverter function. For many applications, this presents no problem and may even be desired.

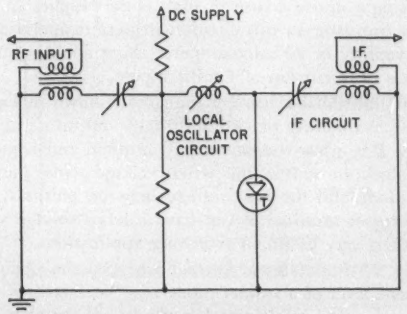


Fig. 7. R-F converter.

Fig. 10 shows how a noninverting circuit might look. The transistor is used in the common base configuration and a germanium diode is used to bias the transistor in an "on" condition provided the tunnel diode is in the low-voltage state. A resistive divider could have been used for the bias if the h_{FE} of the transistor is large though the diode method tends to give some temperature drift compensation. A trigger switching the tunnel diode to the high-voltage state will cause the transistor to be turned off. The collector current level for a given tunnel diode is to be lower for this circuit than that for Fig. 9 due to the absence of the common emitter current gain.

The circuits shown in this article are for p-n-p transistors, however they may be used with an n-p-n transistor if the diode and all power supplies are reversed.

The limited voltage swing for germanium tunnel diodes is not adequate to allow a silicon transistor to be used in the simple circuit of Fig. 9. The use of a fixed bias in series with the base-emitter loop to aid the tunnel diode voltage will allow the circuit to operate properly. One possible approach is shown in Fig. 11.

Some of the tunnel diodes using intermetallic compounds such as gallium arsenide have a much larger voltage swing and thus, for some circuits, it may be possible to use them with silicon transistors without additional bias voltages.

One advantage in using a junction diode to develop the required bias voltage is that the voltage change with temperature will be similar to that for the emitter-base diode.

Using Transistor to modify the I_P of Tunnel Diode. Just as transistors may be used to modify the operating current level of zener or breakdown diodes, they may also be used to increase or decrease the operating current level of tunnel diodes.

If the tunnel diode is placed in the emitter circuit as shown in Fig. 12 (a), the operating current will be decreased by a factor of $(h_{FE} + 1)$. A voltage offset will also occur as illustrated by the input characteristic curve of Fig. 12 (b). Replacing the shorting jumper connected between *C* and *D* with a bias source will reduce this voltage offset to a reasonable value. Point *C* should be made positive with respect to point *D*.

Using a silicon transistor such as the Hughes *2N1255* mesa transistor in this circuit will permit operation in the vicinity of 20 microamperes using a tunnel diode with a peak current of 1 milliampere.

An additional feature of the circuit shown in Fig. 12 is the availability of two additional output terminals. Point *B* is a low-voltage output terminal and is merely the algebraic sum of the actual voltage across the tunnel diode and the bias voltage between points *C* and *D*. Output terminal *A* can have a large voltage swing which is very useful in switching applications.

Fig. 13 illustrates a method whereby the operating current level of a tunnel diode may be increased by a factor approximately equal to the h_{FE} of the transistor.

The voltage offset which occurs is illustrated in Fig. 13(b), and is due to the base-emitter voltage drop of the transistor. A low impedance bias source placed in series with the composite such that the emitter sees a positive voltage can correct, to a great extent, for this voltage offset. If convenient, a small bias source may be placed in series with the tunnel diode itself with such polarity that the base of the transistor is made slightly negative. Output resistance requirements for a bias supply used in the second manner described will be

Fig. 8. Harmonic generator.

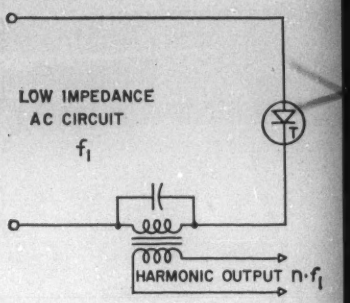
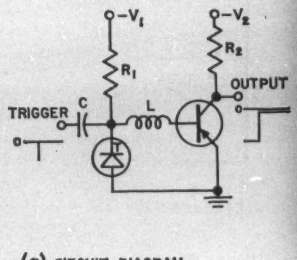
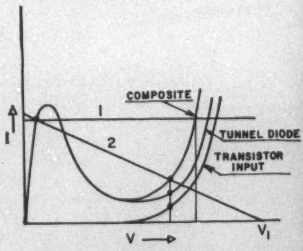


Fig. 9. Binary memory element.

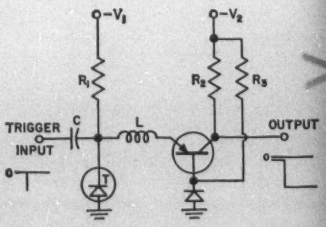


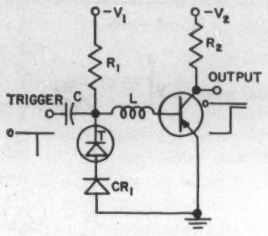
(a) CIRCUIT DIAGRAM



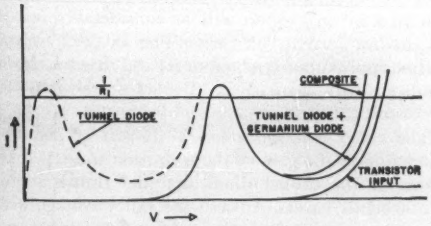
(b) DC OPERATING CHARACTERISTIC CURVES

Fig. 10. A noninverting bistable memory element.



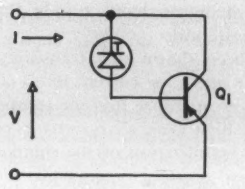


(a) CIRCUIT DIAGRAM

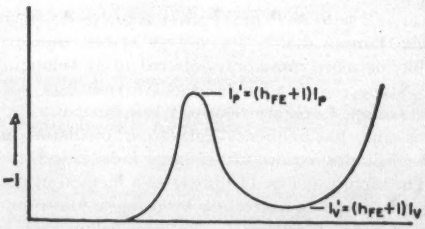


(b) DC OPERATING CHARACTERISTIC CURVES

Fig. 11. Bistable memory element using a silicon transistor.

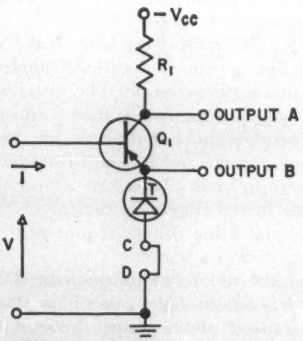


(a) CIRCUIT DIAGRAM

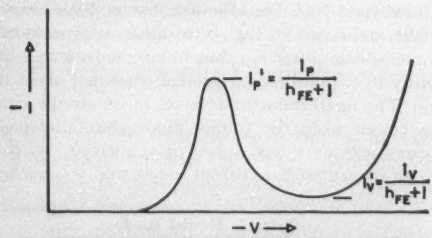


(b) DC OPERATING CHARACTERISTIC CURVE

Fig. 13. A method of increasing the current level of a tunnel diode.

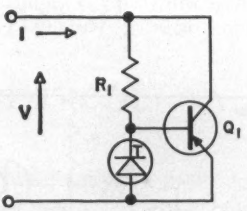


(a) CIRCUIT DIAGRAM

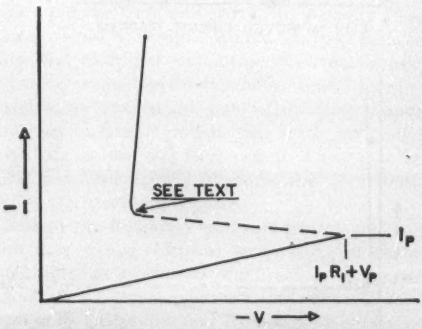


(b) DC OPERATING CHARACTERISTIC CURVE

Fig. 12. Using a transistor to lower the operating current level of a tunnel diode.



(a) CIRCUIT DIAGRAM



(b) DC OPERATING CHARACTERISTIC CURVE.

Fig. 14. Using a transistor to produce an N-type characteristic from the tunnel diode.

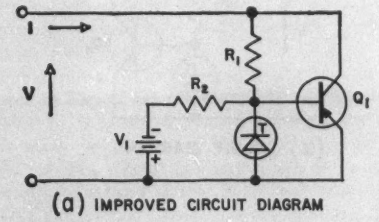
much less stringent than a supply placed in series with the composite unit.

It has been shown that transistors may be used to modify the operating current levels of tunnel diodes. It is important to realize that the composite unit will not possess the high-speed characteristics of the tunnel diode alone and stabilization of the composite device within the negative resistance region may be impossible. The main use of the circuits illustrated would be in low- to medium-speed switching applications or in medium frequency relaxation oscillators.

Circuits with N-Type Negative Resistance Characteristics. Tunnel diodes are voltage stable, short-circuit stable, or more commonly referred to as belonging to the *S*-type classification of negative resistance devices. The voltage levels are relatively low for many applications and low-frequency relaxation oscillators using tunnel diodes require rather large inductances.

The circuit of Fig. 14 illustrates a method of obtaining an *N*-type characteristic by using a transistor and tunnel diode together. As the terminal voltage is increased from zero, transistor Q_1 is not conducting appreciably since the base-to-emitter voltage is too low. The equivalent circuit is thus only the tunnel diode and resistor R_1 up to the point where the current exceeds the peak current of the diode.

At this time, the voltage across the tunnel diode increases sharply thus turning transistor Q_1 on. As long as the current through the diode is greater than the valley current, transistor Q_1 will conduct and a given terminal voltage will yield a much higher current than possible before triggering. The slope of the characteristic in the "on" region will be considerably less than for the low current "off" state. The a-c "off" resistance will be approximately equal to R_1 and that for the "on" condition will approach R_1 divided by the h_{FE} of the transistor.



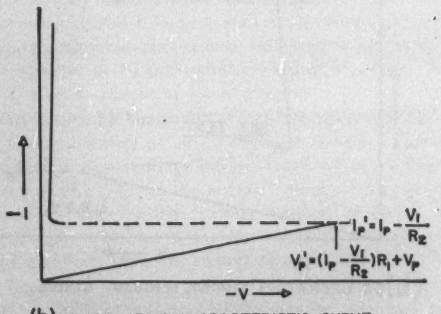


Fig. 15. Improved circuit possessing an *N*-type characteristic.

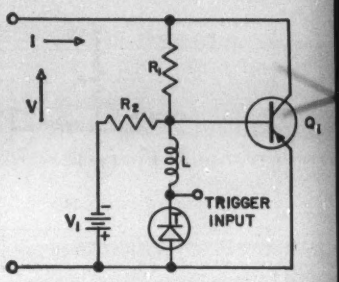


Fig. 16. Circuit with *N*-type characteristic modified for high-speed triggering.

The valley conditions for the circuit of Fig. 14 are a function of the gain of the transistor and the relative shapes of the tunnel diode and the transistor input characteristic curves. At best, the valley voltage will be approximately equal to the product of R_1 and the valley current of the tunnel diode.

The efficiency of the circuit as a switch is thus somewhat impaired by the appreciable voltage drop necessary to maintain the valley current. The improved circuit of Fig. 15 uses a current bias source consisting of resistor R_2 and a voltage source V_1 to decrease the effective valley current and hence the voltage drop in the "on" state.

It is convenient to make the bias current slightly less than the valley current of the tunnel diode–transistor input composite characteristic. The sustaining current required from the terminals is then a function of the difference between the valley current of the composite and the bias current and is hence considerably lower than for the previous circuit. An additional effect is the decrease in the triggering current necessary for a given diode and firing voltage requirement and an increase of the "off" resistance.

As before, the valley conditions of the circuit of Fig. 15 will be a function of the gain of the transistor and the relative shapes of the tunnel diode and transistor input characteristic curves. By careful control of the bias current, this valley voltage may be made quite low.

The circuit of Fig. 15 may be modified one step further as shown in Fig. 16 to allow triggering of the tunnel diode directly, thus taking advantage of its ability to respond to a trigger of extremely short duration. The small inductor L serves to isolate the remaining circuit from the tunnel diode thus allowing the greatest efficiency and speed of triggering. When the circuit is used with a current source and a capacitor to

Table I. Tunnel Diode

Advantages	Disadvantages
Simplicity	Power Supply Requirement
Frequency	Coupling Between Stages
Compatibility	Narrow Voltage Range
Environmental Immunity	Power Handling Capabilities

form a relaxation oscillator, this additional trigger input becomes an ideal point at which to apply a synchronization signal.

SUMMARY

TUNNEL DIODES are new. They operate on a principle unfamiliar to most circuit design engineers. Many of the normal functions of amplification, oscillation and switching, as well as new functions can be performed by tunnel diodes, but unfortunately there are new problems which must be understood and solved before the full capabilities of this device may be fully realized.

Tunnel diodes will be used in high-speed or high-frequency applications where they excel other devices because of better performance, greater simplicity, improved immunity to environmental factors, and possibly a considerable decrease in cost. Table I lists some of the advantages and disadvantages of using the tunnel diode. Several circuits have been presented which show how transistors and tunnel diodes can work together to yield performance which displays desirable features of both devices. It is important to realize that since the transistor is not capable of the high operating speed of the tunnel diode, composite performance will thus be somewhat slower than for the tunnel diode alone. In some cases, as has been shown, the high-speed triggering capability of the tunnel diode can be retained though the performance of the remaining circuitry will occur at a slower rate.

As tunnel diodes are combined in applications such as those shown, an increasing control of the base input characteristic curve will be desirable. In some cases, the insertion of a small bias voltage will allow proper compensation for differences in characteristics.

It is not inferred that the circuits described in this article are the only possible combinations. They are only examples of possible approaches.

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The Changing Electrical Engineering Environment

D. E. GARR
FELLOW AIEE

The fast-changing technical environment requires not only more engineers but a reorientation of curricula upon a strong base of mathematics and physics, greater volume of technical digests and abstracts to cope with the rising volume of technical literature, and increased inter-society co-operation to accommodate the dissolution of the boundaries compartmenting the electrical engineering field.

OUR current technical environment has been described variously as "The Scientific Age," "The Age of Automation," or "Our Exploding Technology." Regardless of the descriptive words used, our technical environment is changing, and changing at a pace which in 1940 would have defied the imagination of the most forward-looking engineer. Since 1939, we have seen the birth and growth to maturity of such technical fields as radar, atomic energy, solid-state physics, and computer technology. New fields such as cryogenics, magnetohydrodynamics, and thermionic conversion are now in the state of incubation and, at our rate of technical growth, will reach maturity before half the golden 60's have passed. These new fields will be mastered largely through the contributions made by electrical engineering.

A look at the frequency spectrum gives a clue to the growth rate of our electrical technology. In the year 1939 the highest frequency which could be generated and controlled even at relatively low power levels was 1,200 mc. In 1959 tubes and circuits were available to produce and control large amounts of microwave power at 50,000 mc. In the year 1960, a giant step forward was made with the announcement by Hughes Aircraft Company of successful tests on their optical maser

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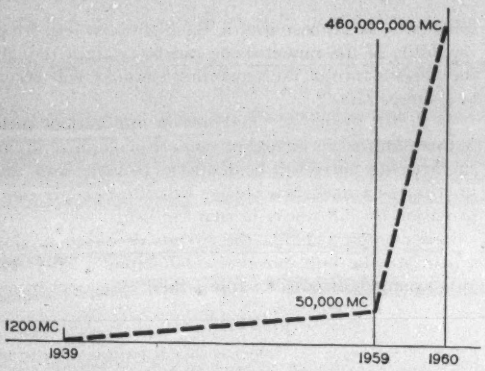


Fig. 1. Rise of controllable frequency.

which makes possible the modulation of power at frequencies of 460 million mc., i.e., control of power in the visible spectrum (Fig. 1).

The number of students who are learning electrical technology and who are readying themselves to push the electrical frontier even further and faster is increasing, but increasing at a rate which is slower than the rate of technological growth. In 1939, 15,680 undergraduate students were enrolled in electrical engineering at accredited schools in the United States. By 1959, this number had increased to 53,849. This 3.5-to-1 increase has greatly complicated the problem of technical communication among electrical engineers, and between electrical engineers and engineers in related fields. If we continue to expand our electrical technology, engineers will have to be even more competent and well-trained, or else the problem of technical communication will become increasingly severe.

CHANGING CURRICULA

ELECTRICAL ENGINEERING CURRICULA in United States colleges has, since World War II, also been undergoing constant change to keep pace with the changing electrical technology. A review of the curricula at three typical schools shows that since 1939 a freshman course in college mathematics has been discontinued at all three and a course in analytical geometry and calculus added in its place. A sophomore course in vectors and differential equations has been added at all three. Two of the schools have added a junior course in complex variables and have discontinued an alternating and direct currents laboratory course. At the senior level, one school has added a course in "Intellect and History of Modern Europe" and has discontinued an electrical engineering design course. One of the schools has added optional courses in transistor circuits, information theory, electromechanical devices, atomic and nuclear physics, abstract algebra, elementary statistics and physical electronics, and since 1939, has dropped optional courses in electrical measurements, electricity and magnetism, electrical machinery, electrical engineering laboratory, vacuum tubes, and a mechanical laboratory. Similar curricula changes can be found in most of our major colleges and indicates that the modern curricula must provide a strong basis of mathematics and physics. With the mastery of these fundamentals, each engineer is then expected to be capable of coping with new technical requirements as they arise, and will have the training necessary to push ahead and reach new technical frontiers.

Technical societies and technical society student branch operations must also change with the new technical challenges; for example, in the field of publications. In 1939, an insignificant number of pages of *Electrical Engineering* were devoted to electronics and related subjects. In 1959, 51.2% of all byline articles in *Electrical Engineering* were devoted to electronics or related subjects. The *EE Digest*, a student publication, was introduced in 1959. The *EE Digest* contains articles believed to be of specific interest to students and a format has been adopted to convey pertinent information in as brief a manner as possible on new developments in all areas of electrical engineering.

At the adult level, special technical conferences have been introduced to cover individual technical problems in greater depth than is afforded at general meetings. These technical conferences, frequently co-ordinated with other societies, have been an innovation of the past decade and now cover subjects ranging from computers to atomic power plants. Thirty-three special technical conferences were sponsored or co-sponsored by AIEE in 1959; of these, fourteen were on subjects which were unknown prior to World War II (Fig. 2).

FUTURE TREND TAKING SHAPE

WHAT OF THE FUTURE? No one has a crystal ball which is infallible; however, these trends, along with their effects on education and publications, appear to be well established:

1. *Greater demands on each student's time.* With the vast amount of technical information to assimilate, combined with the need for more knowledge on world affairs and with the greater social demands, the student will have less free time to devote to technical society and similar extracurricular activities. Every branch

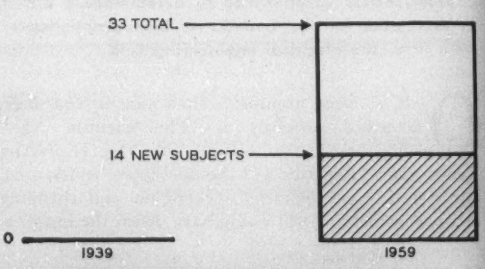


Fig. 2. Growth of technical conferences.

meeting will meet tough competition for the student's time. To meet this trend, the number of student branch meetings will probably decrease, with greater attention given to selection of subject content and selection of participants so that each meeting will have a greater impact and be of greater value to the students.

2. *Increasing store of technical knowledge with a corresponding increase in the volume of technical literature.* All indications point to a faster and faster pace of technological change and with every change in technology, our store of knowledge increases. In order to disseminate this greater store of knowledge, a greater volume of technical articles and books will result. Technical society publications to meet this trend must provide members with an up-to-date account of available literature, but in sufficiently condensed form so that an engineer can attain a picture of the entire field without having to bore through detailed and repetitive accounts. Technical societies must screen out the old information and present only the significant and new information in their publications.

3. *Greater emphasis at the undergraduate level on fundamentals such as mathematics and physics.* This trend, already well under way, seems destined to continue. With greater emphasis on fundamentals and less emphasis on design techniques, the student through his normal course work has less opportunity to find out about his working environment after graduation. The "After Graduation" panels, introduced nationally by AIEE in the Student Branches this year, are one means of providing the student with a first-hand account of the working situation he may face after he leaves school. Technical societies, through publications and branch metings, should provide an increasingly effective experience to branch members relating them realistically to the work they will be doing after graduation.

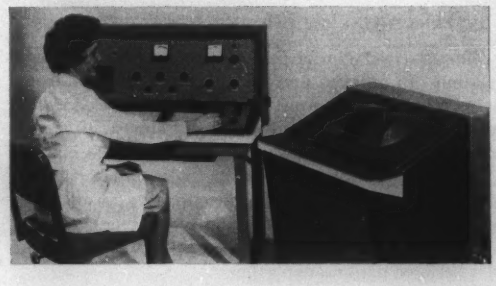
4. *Diminishing difference between engineering disciplines.* With increased attention to the fundamentals of engineering such as mathematics and physics, there will be less distinction between branches of engineering, especially between the fragments of the branches of electrical engineering. In the future, lines between subjects related to electrical engineering will become dimmer and dimmer. To accommodate this already well-established trend, there must be increased co-operation between societies and especially between societies' student branches. To provide maximum service to student members, this co-operation may reach the point where societies may join together and sponsor a single student branch operation which will, in turn, be the headquarters group for a single, on-campus electrical engineering society. Such a move, while affording a greater service to student members, would also eliminate confusion on the campus by postponing the date at which a student must select the technical society which he prefers to join.

New Insight into Organic Molecules

A new scientific instrument, the *A-60* Analytical Nuclear Magnetic Resonance (NMR) Spectrometer, has been developed by Varian Associates, Palo Alto, Calif., that gives chemistry wider knowledge of organic molecules through its sensitivity to the resonance signals of the hydrogen nucleus.

NMR utilizes the fact that the nuclei of certain atoms (notably hydrogen) have spins and can be tipped by a strong magnetic field. The gyroscopic precession rate that results is characteristic of the particular nucleus and is exactly in proportion to the magnetic field strength. The precessing nucleus will absorb or transmit radio energy of precisely this same rate of rotation. Inside the molecule, the applied magnetic field which each hydrogen nucleus experiences is altered some definite amount by the presence and position of adjacent nuclei and electrons. This variation between the magnetic environments of hydrogen atoms occupying different sites in the molecule results in a "spectrum of lines" or "peaks," providing chemical insight into the structure of the molecule from a new perspective.

Instrumentation needed to observe NMR is: (1) r-f transmitter-receiver, (2) magnet capable of producing a



highly uniform and stable magnetic field, (3) means for sweeping the magnetic field, and (4) a graphic recorder driven in synchronism with sweep of the field. The magnet system includes a 6-inch 14,092-gauss magnet with a water-cooled solid-state power supply. Magnetic field homogeneity control coils are provided, as well as a means of spinning the analytical sample in the NMR probe, in order to achieve and maintain the highest resolution.

The instrument can be operated by a technician after a brief training period.

An Engineer Tackles Some Human Relations Problems

H. L. RUSCH
ASSOCIATE MEMBER AIEE

Although the engineer has been very successful in harnessing the physical forces of nature, he has often failed to pay adequate attention to some of the mental forces that may threaten to destroy the world. In this article, some of the research which has been done in the important field of human relations is described.

BEFORE PROCEEDING with our discussion of some of the engineer's problems, let us broaden our perspective and start with a definition of engineering. It has been defined as ". . . the art or science of harnessing the materials and forces of nature for the benefit of the human race."

Take a look at that word "benefit." I am sure we all agree that the scientists and engineers of this and past generations have accomplished a tremendous amount in doing just what that definition encompasses. We are enjoying the highest standard of living in this country that has ever appeared on the face of the earth. Good progress is also being made in raising the standards of living of millions of people in many other countries.

However, most unfortunately, the scientists and engineers have harnessed these forces so that they can also be used for the destruction of the human race. As you know, forces that can result in such total destruction are now at our command.

INTERNATIONAL RELATIONS VS. LOCAL RELATIONS

THE KEY to the problem comes right down to human relations. In order to prevent that word "benefit" from being changed to the word "destruction," we need vastly improved human relations which will almost automatically result in vastly improved international relations.

After all, nations are only groups of men (and women), and men are only grown-up boys, as someone has said. The troubles between boys playing in their back yards have many things in common with the troubles between nations, don't they?

Drawing on the experience of my own boyhood days, one day Charlie and Henry were the best of buddies, and both would be in a bitter feud with Herbert next door. The next day Charlie and Henry would get into a scrap about something, with Henry and Herbert taking sides against Charlie.

Revised text of an address presented originally at the University of Wisconsin, Madison, Wis., May 1, 1959. Also presented at Kingston, N. Y., Feb. 21, 1961, at a meeting sponsored jointly by the AIEE Hudson Valley Section, IRE, ASME, AIIE, and other groups. Recommended for publication by the AIEE Management Committee.

H. L. Rusch is vice-president, Opinion Research Corp., Princeton, N. J.

So, too, it has been with nations, if we will examine history objectively. In the early Forties we were buddies with Russia, and Germany was our bitter enemy. Today we are on the same side of the table with Germany, and Russia is the cold war enemy.

These relationships represent gigantic and tremendously complex problems, to which there are no simple solutions. However, we shall endeavor to outline some basic and fundamental concepts for improving *all* human relationships, which we hope will be useful in thinking and planning for the future.

Some of the same fundamentals which apply to relations between nations also apply in the relationships between the states of our nation, between our great cities, between companies, between labor and management, between families, and even between members of the same family. After all, our great civic bodies consist of nothing more than people—of men, women, boys, and girls.

THE PUBLIC OPINION INDEX FOR INDUSTRY

ALL OF THE IDEAS and concepts herein presented for the betterment of these human relationships are based on the research programs of the Employee and Public Opinion Index for Industry. This is a comprehensive opinion-measuring system which is serving over 80 leading corporations and associations throughout the country.

This work consists of finding out what's in people's heads, and how they feel and act about the problems and issues of the day. Included are international, national, state, city, and county issues, as well as people's relations with their employers, with the medical world, with their educators, with community leaders, and even with members of their own families.

Practically all of the work is done by the personal interview method, and with a national staff of over 1,400 field interviewers, a nation-wide survey of 5,000 to 6,000 interviews can be conducted in a couple of days.

A NEW KIND OF LABORATORY

JUST AS the industrial world has established, over a period of years, very fine physical and chemical laboratories for the benefit of the human race, we believe there is need for another laboratory, which we call, for want of a better term, a research department for better human relations. Such a laboratory should take its place beside our big physical and chemical laboratories.

The products of our wonderful laboratories in the fields of the physical sciences have certainly harnessed

the materials and forces of nature for the benefit of the human race, but, as has been pointed out, the tools for the destruction of the human race have also come out of these laboratories. Some of the same talent which has been employed in the field of inventing instruments of destruction can also be employed in the field of preserving the human race. This is a momentous task, and should be approached very humbly and with great humility. That the job needs to be done, and to be done quickly, nobody will deny.

ORDERING AND FORBIDDING VS. PERSUASION

ONE OF the important concepts in this research program is that we are no longer in an age of "ordering and forbidding"; the problem now is of "engineering consent."

For example, the day when a great railroad leader might say, "The public be damned"—as one did say some years ago—is indeed gone forever. We are now in an age of engineering consent—or the age of persuasion. And if it is granted that American industry and business have moved forward from an age of ordering and forbidding to an age of engineering consent, I think you will also grant that it is far easier to engineer consent, or to persuade, if you first know what's in the mind of the other fellow. That is true at the bargaining table, at the stockholders' meeting, and at the sales meeting.

Going on now to another concept, we are often asked the question, "Shall we comply with all employee and public opinion?"

Shall you comply with the opinion forces that exist between you and your superiors, or between you and the people working under you? We think the right answer to that question is emphatically "No!" We don't hold that the opinion of any person, or any group of persons, is infallible. We think that the right and the realistic approach to the foregoing question is "Either comply or else change that opinion."

Of course, it's relatively easy, as a rule, to comply with the opinion forces with which you may be wrestling. It's when you decide that you need to change those opinions that a great deal of work needs to be done. You have the right, and even the obligation at times, to disagree with the opinion forces that you are facing, and it is at such times that your skill and your ingenuity are taxed to the utmost.

Another basic concept which we think very important is this:

$X + Y$ = Good Human Relations
where
X = The Deed
Y = The Interpretation of the Deed

Whether you are striving for good employee relations, good public relations, good community relations, good faculty relations, or even good family relations, this concept applies.

When it comes to good employee relations, a few of our top business executives still have the mistaken idea that good deeds speak for themselves. Again and again we find cases in our opinion surveys where employees with a very good job package don't even know what's in their package. They may have a very high equity in a pension plan that has built up over a period of years, but, lo and behold, half of them don't even know that they have such a plan.

The above concept also applies in the field of international relations. As you know, Uncle Sam—which includes you—is spending billions of dollars in aid to other countries, but our government representatives, who travel around the world, come back with reports that many people do not have much love for Americans, to put it mildly. True enough, some of our deeds around the world could be improved, but where we fall down principally is in the interpretation of our deeds.

Every person can use the foregoing concept in his daily work, and in his family relations. If Dad makes a certain family decision, and fails to interpret that decision, he doesn't get the best family relations. You have to explain—to interpret what you do—in the interests of good human relations.

Now let us examine another area in human relations where a great deal of enlightenment and interpretation are needed. There is a fabulous misconception about the profits which business is making. In answer to the question, "How much profit per sales dollar, after taxes, does industry make?" the "general public" median average guess is 21 cents. The true figure is 3.7 cents, which actually does not vary much from year to year. So here you see the opinion, and the fact.

About this time you may be asking, "Well, what difference does that make?" Let's take a look at it!

Can Companies Afford Sizable Wage Increases Without Raising Prices?

	Yes	No	No Opinion
"General public" replies	50%	34%	16%
Union member replies	67%	22%	11%

Hence, that little misconception about profits just pointed out results in terrific pressures around the bargaining table, does it not?

With a difference between income and outgo on the balance sheet of 21 cents, you will grant that there is quite a bit of opportunity to raise wages without having to raise prices. On the other hand, if you knew in your mind and heart that there is only a 3- or 4-cent difference, I think you would agree that it is very difficult to move very far without going into the red.

Looking at specific industries, how much profit, after taxes, does the meat packer make on a dollar's worth of beef? The general public says 22 cents. As I think most of us know, Swift and Company works very hard to make even 1 cent profit on the sales dollar.

How much profit does the auto manufacturer make on $2,000 that he gets for a car? $450 says the general public. General Motors makes somewhere around 8 or 9%, which is quite a bit more than the meat packers, but nowhere near the 22½% that the public thinks the auto manufacturer makes.

How about profits of business as a whole—are they too much, too little, or about right? Chart A shows how various groups feel on this subject.

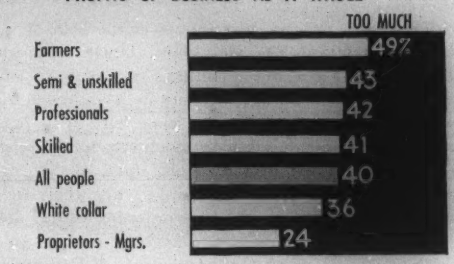


Chart A

Note here that the farmers are most critical; 49% say that business' profits are too much. Of the nation's semi- and unskilled workers, 43% say profits are too much. Among skilled workers, 41% say so. But note the professionals—the doctors, the lawyers, the teachers, and the preachers—they are just as critical of industry's profits as the members of the CIO.

On the average, 40% of all people say that profits are too much. About a third of those in the white collar group say so, and among the small proprietor and manager group, about a fourth of them criticize profits.

As a consequence of all these misconceptions about profits, the average businessman is usually portrayed as a fellow with a big dollar sign on his chest, big fat jowls, etc.

No doubt the average businessman likes to think of himself as a fellow who is trying to do the right thing. And it does take an economic statesman, does it not, to stay in the black in this highly competitive business and industry world in which we are all working.

SECURITY

THE FORCES that motivate human behavior need further careful study in such areas as security and the so-called "guaranteed annual wage."

We have asked people across the country, "Who should get credit when there are good times in the nation?" About 40% say the Government or the Administration, 18% say business and industry, and 12% say labor. Thus, people credit the "Government" when everything is going well.

And when we turn the coin and ask "Who should be blamed for bad times?" about 48% say the Government or the Administration, 15% say business and industry and 5% say Labor. As we can see, the blame is again placed on "Government."

The final shocker was the answer to the question, "Is it a Government responsibility to guarantee prosperity?" Believe it or not, 72% of the people say that it is; only 17% say that it is not; 11% had no opinion.

The realistic answer to these questions is that the primary responsibility for these things is our own productivity! The Government is merely an "umpire" and basically not a producer of wealth.

When you think objectively about these three questions and the answers the general public gives, it is not very difficult to understand why people are pressing in the direction of such things as the so-called "guaranteed annual wage." And, of course, back of that is the whole subject of security. The great desire for security is at the root of the pressures with which many of us are wrestling.

We are all interested in security, are we not? So, let's not dispute the good ends here. Let's agree that we all want security. Let's center the debate on how we are going to get that security, and not on whether security is a bad thing or a good thing.

Main Things People Are Concerned About That Make Them Feel Insecure

Top Mentions	Manufacturing Employees
Fear of losing job	58%
Making enough money	18%
Having enough for old age	17%
Sickness and accidents	13%

Here we see that "fear of losing job," among manufacturing employees, is at the top of the list. "Having enough for old age" is cited by 17%.

Some people take the position that jobs can be guaranteed—the guaranteed annual wage, for example. The realistic answer to that point of view is, of course, this: "Any form of money that is paid out for not working must ultimately be paid for by somebody working."

Unfortunately, great masses of people do not understand this important fact of life, and, in the interest of much better human relations, the task is to make it clear to them. This is a tremendous assignment for our vast communications systems!

THE NEW DRIVE ON SCIENTIFIC EDUCATION

LET US look at another problem area, which falls right in the center of our educational world. We asked the United States public "Which country does the most to educate scientists, Russia or the U.S.A.?" They replied 64% to 13%, or about five to one, that the Soviets are ahead of us in educating scientists. The score is 39% to 28% that they have the best high school training in math and science.

Defining the problem, the facts are that in the U.S.A. 2 in 3 high school students don't take chemistry; 3 in 4 don't take physics; and 7 in 8 don't take either trigonometry or solid geometry.

A good question is "Why don't more young people study science?" Here is what the U.S. public says:

Lack of Motivation	
Not encouraged by teachers, parents	21%
Not enough interest	18
Lazy	13
Not enough money in it	10
Not enough prestige	4

Inability

Inadequate educational system	16%
Not intelligent enough	15
Financially unable	7

When the nation's number two goal is the training of more and better scientists, this is not a very encouraging picture.

Chart B shows how a majority of the public rates five important careers on five major criteria.

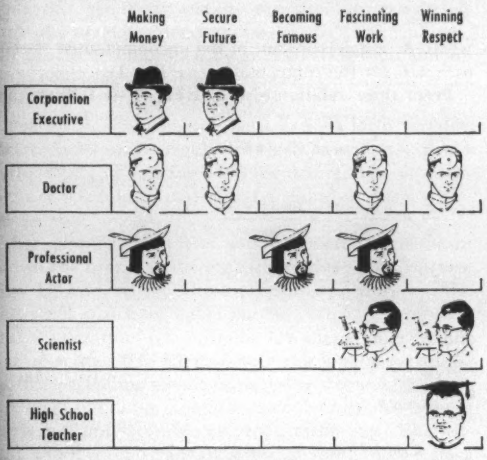


Chart B

The "corporation executive" rates high on "making money" and "having a secure future." But he does not rate very high on "fascinating work" and on "winning respect." The doctor's career appeals on four of these criteria. Apparently, every mother would like to see a son become an M.D. The professional actor rates high on "making money" but not so high on a "secure future" and "winning respect." As you see, the scientist rates high on having "fascinating work" and "winning respect," but not so high on the first three criteria. And the high school teacher rates high on "winning respect," but that is about all.

The public is in a mood for far-reaching change in our educational system. The nation's 9,000 school administrators have been in a lively debate over the recommendation of their 2-year study group for advanced high school courses for particularly promising students.

"Should high schools have special classes for bright students?" Answers to this question were "yes"—62%, "no"—27%, and "no opinion"—11%.

The issue of democracy is involved! But a majority of the public now believes that we *should* have special classes for bright students; 62% are in favor.

WHAT IS TROUBLING INDUSTRY'S ENGINEERS

ANOTHER PROBLEM AREA is industry's man hunt for engineers and scientists. Commonest gripe of engineers is that they have too much routine work; in fact, 77% of industry's engineers have this complaint. They contend that much of this routine work should be turned over to technicians or other assistants.

Related to his gripes is a list of job values which the engineer likes most. High on the list is interesting work, 74% name this. Next comes "people he works with," named by 63%. (There are multiple answers, and hence the figures add up to more than 100%.)

What Job Values The Engineer Likes Most	% Naming This Item
Interesting work	74%
People he works with	63
Security	40
Employee benefits	40
Amount of responsibility	37
Immediate supervisor	35
Working conditions	32
Chances for advancement	31
His pay	23
Credit for good work	18
Opportunity for further education	12
Personal interest company takes in him	8

"His pay" ranks ninth on this list. This does not mean that pay is unimportant. Pay is, and always will be, an important job ingredient. But in survey after survey we have found that there are usually several job values which rank very definitely above pay.

In general, relations between engineers and company management are pretty good. The engineers have their gripes, and they do not hesitate to express them. But, 18% say their relations with company management "in our company" are "excellent," and 52% say "good." Only 24% say they are "fair" and 3% say "poor." This leads right into the subject of collective bargaining for engineers. Based on many studies of this subject, including nationwide surveys among members of the AIEE, the American Society of Civil Engineers, and many other groups, a great majority of industry's engineers reject collective bargaining as the way to advance their cause. Union leadership arguments for organizing engineers run into a wall of opposition. The over-all response to the question of collective bargaining for engineers summarizes about as follows:

Collective Bargaining for Engineers?

All right	12%
Should stay out	84%
No opinion	4%

THE MIND VS. THE MACHINE

WHENEVER working with problems in human relationships, everyone agrees that we are dealing with exceedingly complex things. Man has invented and built some amazingly complicated machinery. Those almost human computers are excellent examples. However, as someone recently said, referring to those complex computers, "Somebody, somewhere, and in some way, must still tell that machine what to do before it can begin functioning." After all, every machine that has ever been built has come out of someone's mind. And, as Charles Lindbergh said in one of his articles, the mind therefore must be bigger than the machine!

Servo Compensation Based on Root Locus Approach

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USING a few simple rules, it is possible to design a compensator which will provide a feedback control system with a pair of complex conjugate roots of a preselected value. This can be done while simultaneously maintaining any specified value of gain (K_p, K_v, K_a, etc).

In general, the characteristic equation of the closed-loop system is specified by

$$1 + GH(s) = 0 \tag{1}$$

where $GH(s)$ is the loop transfer function. The roots of this equation are readily evaluated using root-locus techniques. Assume that the designer has evaluated $GH(s)$ for a given system, has determined the minimum acceptable gain, and has determined the s-plane coordinates at which he desires to locate a pair of complex conjugate roots without altering the steady-state accuracy. If the desired location of a root is r, then r

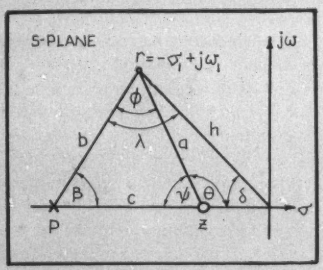

Fig. 1. S-plane diagram for the derivation of equations.

is not on the root locus of $GH(s)$, the phase angle of $GH(s)$ is not $180N°$ at r, but is some other number which may be computed by using the spirule, or by substituting the s-co-ordinates of r in the equation for $GH(s)$. The angle, ϕ, which a compensator must provide to place point r on the compensated root locus is obtained by subtraction. The "root-locus gain" at $s = r$ may also be computed from the original $GH(s)$

$$G = \left| \frac{r^n (r + P_1)(r + P_2) \ldots}{(r + z_1)(r + z_2) \ldots} \right| \tag{2}$$

Note that the spirule may also be used to evaluate G. The vector ratio contributed by the compensator is

$$g = \left| \frac{a}{b} \right| \tag{3}$$

when the compensator is a single pole-single zero filter, and a and b are the distances from the pole and zero to r as defined by Fig. 1. Thus, the "root-locus gain" of the compensated system at point r is G/g. To satisfy steady-state requirements it is necessary that

$$K = G\,\alpha/g \tag{4}$$

where K = gain constant of the uncompensated system, $\alpha = z/P$ for the compensator (see Fig. 1).

From these relationships and Fig. 1, it follows that

$$\alpha = \frac{z}{P} = \frac{z}{z + c} = gK/G = aK/bG \tag{5}$$

$$\frac{z}{a} = \frac{K(z + c)}{bG} = \frac{\sin(\lambda - \phi)}{\sin \delta} \tag{6}$$

$$\frac{z + c}{b} = \frac{\sin \lambda}{\sin \delta} \tag{7}$$

and by manipulation

$$z = \frac{hK}{G} \frac{\sin \lambda}{\sin \theta} \tag{8}$$

$$P = \frac{h \sin \lambda}{\sin(\theta - \phi)} \tag{9}$$

where $\lambda = \cot^{-1}\left(\cot \phi - \frac{K}{G} \csc \phi\right)$ and $\theta = \pi + \phi - \delta - \lambda$

To design the single section compensator one merely substitutes in equations 8 and 9. Note that h, K, G, ϕ, and δ are effectively given by the specifications and computation of θ and λ is easy.

For a given system, zones can be sketched on the S-plane showing the areas where r can be located using a single section compensator. Multiple identical sections may be designed using, for n sections:

$$z = h \left(\frac{K}{G}\right)^{\frac{1}{n}} \frac{\sin \lambda_n}{\sin \theta_n} \tag{10}$$

$$P = \frac{h \sin \lambda_n}{\sin(\theta_n - \phi_n)} \tag{11}$$

where

$$\lambda_n = \cot^{-1}\left(\cot \phi_n - \left(\frac{K}{G}\right)^{\frac{1}{n}} \csc \phi_n\right)$$

$$\theta_n = \pi + \phi_n - \delta - \lambda_n$$

$$\phi_n = \phi/n$$

Multiple nonidentical sections may be designed by repetition of the single section design procedure.

Digest of paper 60-779, "Design of Servo Compensation Based on the Root Locus Approach," recommended by the AIEE Feedback Control Systems Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Summer General Meeting, Atlantic City, N.J., June 19-24, 1960. Published in AIEE *Applications and Industry*, Sept. 1960, pp. 272-77.

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A Regulator for Aircraft D-C Generators

A. L. WELLFORD

IN ORDER to self-excite and regulate a d-c generator, a device is needed which can vary the current supplied to the shunt field of the machine so that regulated voltage results over a wide range of speed and load. In addition, it must provide some means of load sharing when one generator and its regulator are paralleled with one or more identical systems. In 71 C ambient, this can be accomplished by a carbon-pile regulator or by a switching-type regulator using germanium transistors.

For 120 C ambient, the need existed for a reliable and accurate static regulator which would exceed the performance of existing 71 C regulators. The development of a regulator that would accomplish this was the design goal.

To minimize watt loss and, therefore, temperature rise in the unit, a switching rather than a linear device must be used. As the silicon-controlled rectifier was the best static switch available for the current (8 amperes) and temperature (in excess of 120 C) requirements, it was selected. Also selected was a magnetic-controlled rectifier switching circuit using a single controlled rectifier and obtaining commutation or turn-off from a capacitor and saturable current transformer. This circuit produces a relatively constant-width field-voltage pulse each time the controlled rectifier is gated. To vary the average field current, it is only necessary to vary the frequency of the gating pulses.

A unijunction transistor relaxation oscillator is used to supply the gating, its frequency controlled by the voltage level fed to its charging circuit. Note in the block diagram of Fig. 1 that certain logic is imposed

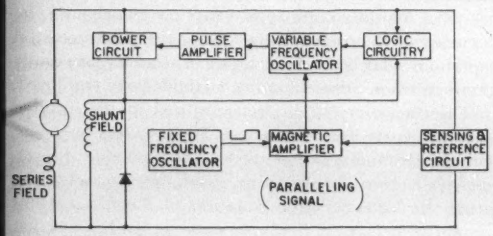

Fig. 1. Circuit approach block diagram.

on the oscillator. This is necessary to inhibit gating of the controlled rectifier under any condition which might result in commutation failure. The additional complexity in gating circuitry makes possible the use of a simplified power circuit. Commutation of the controlled rectifier is accomplished by the switching action (saturation) of a magnetic core and not by auxiliary semiconductors. The logic circuitry assures that both the generator field and the armature voltages are proper for commutation before rectifier gating occurs. This eliminates commutation failures under all possible system conditions including system faults and voltage transients.

The generator voltage and load division error signals are fed to separate windings of a magnetic amplifier. The variable output voltage of the magnetic amplifier supplies the charging circuit of the oscillator. A magnetically coupled multivibrator generates the necessary alternating voltage for the magnetic amplifier and also is a source of transistor bias voltages. The regulating loop is completed by the sensing and reference circuit which compares the generator voltage output with a breakdown diode and generates an error signal for the magnetic amplifier.

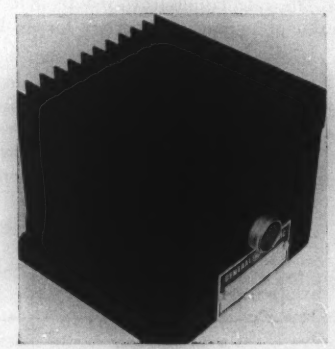

Fig. 2. Photograph of unit.

In packaging the regulator, care was taken to isolate the thermally critical components from the noncritical ones. A very low thermal impedance was achieved between the controlled rectifier stud and its heat sink, yet electrical isolation was maintained. The final package weighs 6¼ pounds and will fit within the envelope required for a standard carbon-pile regulator.

The finished unit shown in Fig. 2 is able to supply 7 continuous field amperes and up to 8 amperes for 1 hour while operated in 120 C ambient. The voltage regulation over the speed, load, and temperature extremes is 28 ±¾ volts d-c. This regulator can provide more than adequate performance in advanced aircraft requiring 120 C operation.

Digest of paper 60-1031, "A Controlled Rectifier Regulator for Aircraft D-C Generators in 120 C Applications," recommended by the AIEE Aero-Space Transportation Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Pacific General Meeting, San Diego, Calif., Aug. 8-12, 1960. Published in AIEE *Applications and Industry*, Nov. 1960, pp. 411-16.

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Current Asymmetry in Resistance–Reactance Circuits

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THE DUTY on electrical protective devices, among other factors, is determined by the extent of current asymmetry, which is a function of the circuit short-circuit ratio and the instantaneous value of voltage at which switching occurs. Asymmetrical current consists

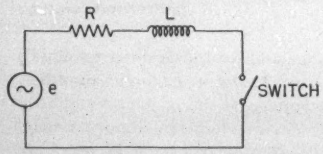

Fig. 1. R-L circuit.

of symmetrical alternating current and unidirectional current. Depending on the current time constant, expressed either by the short-circuit ratio or power factor, the unidirectional current may be nearly damped out during the first half cycle, or persist for several cycles.

The calculations involved in determining the rms value of asymmetrical current for the first current loop

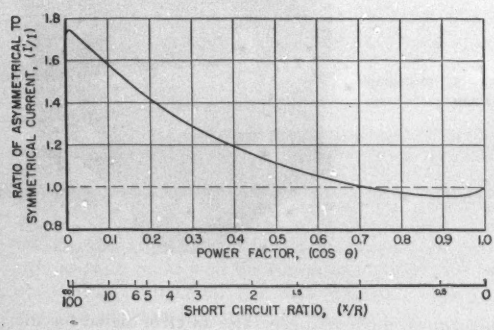

Fig. 2. Ratio curve.

are extensive, even for the simple circuit shown in Fig. 1, since the solution of a transcendental equation is required. Methods of approximating the rms value of asymmetrical current have previously been developed. The values of asymmetrical current herein presented

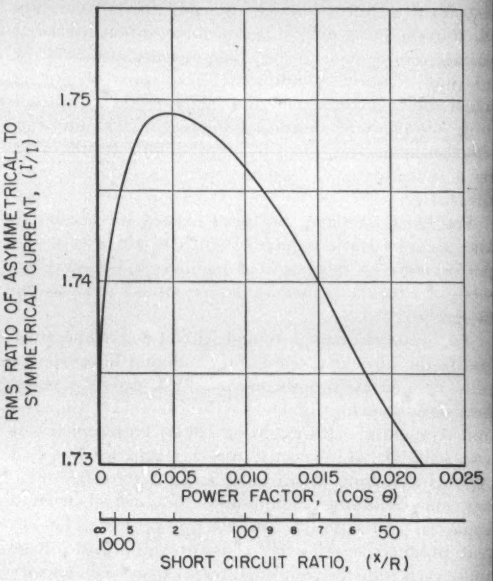
RMS RATIO OF ASYMMETRICAL TO SYMMETRICAL CURRENT, (I'/I)
1.75
1.74
1.73
0 0.005 0.010 0.015 0.020 0.025
POWER FACTOR, (COS θ)
∞ 1000 5 2 100 9 8 7 6 50
SHORT CIRCUIT RATIO, (X/R)

Fig. 3. Ratio curve, upper boundary.

represent solutions of the equations by direct caculation and, thus, eliminate the approximations which were necessary in the previous analysis. In as much as this method necessitates a great number of calculations, the use of a digital computer becomes advantageous. The accuracy of the computer in solving the transcendental equations is far beyond the degree of accuracy previously attained when approximating methods were employed.

The computer output is reproduced in the form of the ratio curve shown in Fig. 2. For practical purposes, current asymmetry is expressed as the rms value of asymmetrical current for switching at voltage zero and evaluating the transcendental equation to the first current zero after switching. From the curve it can be seen that the ratio of asymmetrical to symmetrical rms current, I'/I, is unity at two points: when the short-circuit ratio is equal to zero and when it is approximately equal to unity. Between these two points, it is interesting to note that the ratio is less than unity. Also, it may be noted that as the short-circuit ratio approaches infinity, the value of I'/I approaches the square root of three; however, the maximum value is slightly larger, as shown in Fig. 3. These data should prove to be valuable to design and test engineers for accurately predicting the value of asymmetrical current.

Digest of paper 60-825, recommended by the AIEE Switchgear Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Summer General Meeting, Atlantic City, N. J., June 19-24, 1960. Published in AIEE *Power Apparatus and Systems*, Dec. 1960, pp. 897-900.

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Transient Behavior of an Aluminum Pot-Line

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OVER A PERIOD of several years a number of transformers and induction regulators supplying energy to aluminum pot-lines and similar installations have been damaged by insulation failures, apparently resulting from abnormal overvoltages. The transformers used for these applications generally step down from 13.8 kv to a secondary voltage in the range 600 to 900 volts. A basic impulse level of at least 40 kv is normal for the secondary winding. The fact that insulation failures occur on these windings is an indication of the severity of the voltage transients, and clearly shows that they are out of the range of normal switching transients. However, in many cases it is difficult to see how such voltage surges could invade the low-voltage system from the high-voltage side of the power transformers. This points to some other means of surge generation in the low-voltage circuit, and a likely cause is current suppression.

It is well known that when the current in a circuit changes suddenly, a voltage is produced which is given by the product of the current suppressed and the surge impedance of the circuit. Such suppression has been observed in mercury-arc rectifiers and in circuit breakers (current chopping). The pots in a pot-line behave erratically from time to time, although the effect of this on the circuit is not fully understood. The principal purpose of the investigation was to study the consequences of current suppression at various possible points of origin, and so determine the degree of suppression at these locations required to generate overvoltages of the amplitude observed. In this way it was hoped to show whether current suppression could reasonably account for the voltage transient, and perhaps also give some clue concerning the circuit component responsible.

The transformers, rectifier equipment, and bus work associated with an aluminum pot-line constitute an extensive and complicated system with many components in series and parallel combination. When a current suppression occurs at any point in such a system, it is equivalent to injecting into the circuit at the point of suppression a negative step function of current whose amplitude is the same as the amplitude of the current suppressed. This will spread through the system, dividing and redividing as it encounters nodes in the network. In each branch it will generate a voltage equal to the product of the surge impedance of that particular branch and the fraction of the suppressed current flowing in that branch. Each component will respond, usually with an oscillation at a frequency peculiar to itself. The transient seen across any two points in the network will be the sum of the responses of components beyond those points, which are in the path of the injected current.

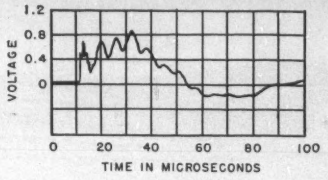

Fig. 1. Response of system to 20-milliampere step function of current injected at rectifier terminals. Response is measured close to point of injection.

To investigate the behavior of a new aluminum pot-line installation about to be commissioned at the Lister Hill plant of Reynolds Metals Company, an experimental technique closely paralleling the theory outlined was applied, that is, step functions of current were injected into the system at points where it was deemed that current suppressing action might take place, and the voltage disturbances created were monitored at many points about the circuit.

The currents were injected repetitively in synchronism with the time base of the oscilloscope that was used to observe the voltage transients. Using this recurrent technique, what were fast transient disturbances appeared as steady traces on the face of the oscilloscope.

As anticipated, the results revealed multifrequency transients; Fig. 1 is typical. By observations at a number of different points, it was possible to identify the different constituents with physical components in the system. It was found, for example, that the largest spikes of voltage were generated by the excitation of short lengths of bus, whereas an interphase transformer gave a much lower frequency response of somewhat lower amplitude. It was also established how far from its origin a disturbance could be felt. Specifically, it was found that if a current suppression occurred in a rectifier, significant overvoltages would be limited to its particular skid and the transformer bank feeding it. Values of surge impedance for the components of the system were found to be in the range 0 to 100 ohms, which implies that abrupt suppressions of several hundred amperes would be needed in order to generate serious overvoltages. Putting together the various pieces of information elucidated from the tests, indications are that the mercury-arc rectifiers are the most likely source of the disturbance.

Digest of paper 61-20, "An Investigation of the Transient Behavior of an Aluminum Pot-Line Installation," recommended by the AIEE Industrial Rectifiers Committee and approved by the AIEE Technical Operations Department for the AIEE Winter General Meeting, New York, N. Y., Jan. 29–Feb. 3, 1961. Scheduled for publication in AIEE *Applications and Industry*, 1961.

Allan Greenwood and W. C. Kotheimer are with the General Electric Company, Philadelphia, Pa.; C. A. Langlois is with the Reynolds Metals Company, Richmond, Va.

INSTITUTE ACTIVITIES

New Horizons To Be Theme of AIEE North Eastern District Meeting

NUMERICALLY controlled machines being built and operated will be viewed on an inspection tour to the Pratt & Whitney Machine Tool Company during the North Eastern District Meeting. These machines include a jig borer, a Keller milling machine, a rotary table, and a tape controlled automatic turret lathe. This tour will follow the previous day's session on industrial automatic control.

THE AIEE North Eastern District Meeting will be held at the Statler Hilton Hotel in Hartford, Conn., on May 17-19, 1961. Electricity's part in the creation of ever widening and challenging new horizons will be the dominant theme of the meeting. In industry, in communications, and in power supply, new and expanding developments will be discussed at six technical sessions.

Papers in the technical program will cover new and important aspects of power systems' generation, transmission, and distribution.

Subjects covering the latest in control systems, their tie with automation, new methods and ideas in process heating, and the ever-increasing use of computers will attract wide attendance from the heavily industrialized New England areas.

For those interested in communications, a variety of speakers on telephone and radio developments, including miniaturization and instrumentation, will be on the program. Such subjects as touch tone telephoning, selective calling for mobile radio, and communications systems for centralized data processing highlight the theme of "Horizons Unlimited."

Complementing the technical presentations will be inspection trips to view equipment discussed in the sessions. These will include the electrical controls and apparatus to serve a large office building, the automatic machines of large factories with their automated production equipment, the latest in microwave repeater stations, a nuclear bomb-proof dispatch center, a redevelopment area, and a reactor development laboratory.

Hartford is easily reached by auto over turnpike roads from all of New England. Persons from the New York City and Long Island area can reach Hartford in a 2- or 3-hour drive.

Those attending are urged to fill out registration cards at once and to mail them. This will help at the registration desk and assist the committees in planning for arrivals.

The registration desk will be open in Room 428 from 2:00 to 5:00 p.m. on Tuesday, May 16, the day preceding the meeting. It will reopen at 8:00 a.m., Wednesday, in the Foyer and remain open all during the meeting. Registration fees are $4 for members, $7 for nonmembers, $2 for ladies, and no fee for student members.

Hotel Reservations

A block of rooms has been set aside at the Statler Hilton Hotel, Ford and Pearl Streets, Hartford 3, Conn., for members and guests attending the meeting. Requests for reservations should be sent to the hotel in care of the "Front Office Manager," specifically referring to the AIEE meeting. More than one hotel should not be contacted. If a request cannot be filled, the Statler Hilton will automatically refer the request to the Hotel Accommodations Committee which will obtain a similar reservation at another nearby hotel. The hotel will confirm each reservation.

Reservations should be made as early as possible to obtain the best accommodations.

Rooms have been allotted for those attending the meeting at the following daily rates:

Statler Hilton Hotel (Meeting Headquarters), Ford and Pearl Streets

Single Room	$8.00 to $12.00
Double Bedroom	$13.00 to $15.50
Twin Bedroom	$16.00 to $18.00

(More than two persons in one room: For each additional person in double or twin bedroom, the extra charge is $3.50 per day.)

Suites—Living Room, Bedroom, and bath for one or two ..... $27.50 to $43.50

Special Student Rates .. $6.50 per person
$11.00 for two persons
$13.50 for three persons

All rooms have private bath

Ezra Stoller Associates

CONNECTICUT General Life Insurance Company's home office building in Bloomfield, 5 miles northwest of downtown Hartford, will be visited during the North Eastern District Meeting. This building has been selected by the American Institute of Architects as one of the "Ten Buildings in America's Future."

Although no rooms have been set aside at the following hotels, they are available as follows (both hotels are within a block of the Statler Hilton Hotel):

Shoreham Motor Hotel, 440 Asylum St., Hartford
Single Room ..... $10.50 to $14.00
Double Rooms, Twin or Double Beds
Two Persons ..... $14.00 to $17.00
Three Persons ..... $17.50 to $21.50
Suites, Two Persons ..... $25.00 and up
Hotel Bond, Asylum St., Hartford
Single Room ..... $6.60 to $10.50
Double Bedroom ..... $9.50 to $13.00
Twin Bedroom ..... $11.00 to $15.00
Every room with private bath
Suites $20.00 and up

For additional information, if needed, contact M. E. C. Devine, Chairman, Hotel Arrangements Committee, c/o Westinghouse Electric Corporation, 119 Ann St., Hartford, Conn.

Wiles Studio

AN aerial view is shown of the Allen Manufacturing Company of Bloomfield, selected as one of the many plants to be toured at the North Eastern District Meeting. Of prime interest here is the unique plant electrical distribution system designed to give the ultimate in flexibility at minimum installation cost.

Luncheons

The Opening Luncheon, at 12:15 p.m., Wednesday, May 17, will be held in the Ballroom of the Statler Hilton. The District Meeting chairman will preside. Governor J. R. Dempsey of Connecticut will address the members.

Tickets will be $3.25 per person, available in the Foyer.

The Ladies' Luncheon, at 1:00 p.m., Wednesday, in the Mark Twain Suite at the Shoreham Hotel, will feature a fashion show by Connecticut's leading center of fashionable women's wear. Tickets will cost $3.00 per person in the Foyer.

The President's Luncheon, at 12:15 p.m., Thursday, May 18, will be in the Ballroom. The chairman of the District Meeting will preside. AIEE President C. H. Linder will be the speaker. Tickets will cost $3.25 per person, available in the Foyer.

The District Vice-Presidents' and Students' Luncheon, at 12:15 p.m., on Friday, May 19, will have Vice-President F. S. Bacon presiding. Student awards will be presented. Tickets will be available in the Foyer, at $3.25 per person. There will be no charge for student members.

Evening Events

On Wednesday, a social hour will be held at 6:30 p.m. in the Buffalo-New York-Washington Room, for the members and their ladies. This will precede the Ladies' Dinner and the Men's Smoker.

At the Ladies' Dinner, at 7:30 p.m. in the Hartford Room, Miss Priscilla Hiers will describe her trip around the world as a member of the crew of the brigantine "Yankee." Tickets will cost $5.00

The Men's Smoker at 7:30 p.m. in the Ballroom will have several acts of professional entertainment, including The Agostinos, a surprise acrobatic novelty act, Black & Nolen as "Beauty and the Least," and Jacqueline James, singing comedienne. Tickets will cost $6.50 per person.

On Thursday, a social hour beginning at 7:00 p.m. will precede the Dinner Dance at 8:00 p.m. Dress will be semi-formal. The officers of the host Connecticut Section will be recognized at the dinner. Tickets will cost $6.75 per person.

Ladies' headquarters will be open all during the meeting. Mrs. J. D. Guy, with co-chairman, Mrs. L. B. Grew, and their committee, have planned an interesting program for the ladies.

Ladies' Program

There will be a coffee hour each day at 9:00 a.m., and a luncheon and fashion show at 1.00 p.m. on Wednesday. That evening at 6:30 o'clock, they will enjoy cocktails with the men, followed by a dinner at 7:30.

On Thursday morning at 10:00 a.m., a visit is planned to "The City Within a Building," the Connecticut General Life Insurance Company. Thursday afternoon, the ladies will be on their own to enjoy the shops and points of interest in Hartford.

Thursday night at 8 o'clock, they will "Dine and Dance" in the Ballroom of the Statler Hilton Hotel. The Connecticut Section this year is combining its customary annual dinner dance with that of the North Eastern District.

Student Activities

No registration fees are required for students. All student activities are scheduled for Friday, May 19.

The counselors and students will be the guests of the District at a breakfast meeting at 8:00 a.m. Student prize papers will be presented at 9:00 a.m.

Students and counselors will be the guests of the Connecticut Section at the District Vice-President's and Students' Luncheon at 12:15 p.m., when the student awards will be presented.

Special rates are available to the students in the Statler Hilton only. (See registration information.)

The Student Branch Chairmen Meeting will take place Friday at 2:00 p.m.

The Connecticut Section Annual Meeting will be held Thursday at 4:30 p.m., with reports of officers and election results.

On Friday at 2:00 p.m., the North Eastern District 12 Executive Committee Meeting will be held.

Members of the North Eastern District 12 Meeting Committee are: C. T. Hughes, chairman; C. L. Derrick, vice-chairman; J. M. Schamberger, secretary; A. E. Sapega, chairman, Registration Committee; J. D. C. Guy, chairman, Entertainment; R. W. Boyd, chairman, Inspection Trips; Theodore Newcomb, chairman, Transportation Committee; M. E. C. Devine, chairman, Hotel Arrangements; D. C. Switzer, chairman, Technical Program; H. M. Marsden, chairman, Student Activities; Mrs. L. B. Grew and Mrs. J. D. C. Guy, co-chairman, Ladies' Activities; Q. Q. Quinn, chairman, Publicity, and E. A. Johnson, chairman, Finance.

Inspection Trips

Inspection tours have been scheduled to the following places:

Wednesday, May 17 (1:30 p.m.) Connecticut General Life Insurance Company, Bloomfield. The bus will leave the hotel main entrance. Tickets will cost $1.00 per person. The "City Within a Building," this 600,000-square-foot office building is of the most modern type. A film, "Building For Tomorrow," will be shown. In it the erection and construction of building are depicted.

Thursday, May 18 (9:00 a.m.) Allen Manufacturing Co., Bloomfield. The bus will leave the hotel main entrance. Tickets will cost $1.00 per person. This is a new plant equipped for the highest worker efficiency by the use of an ideal productive environment secured by high levels of illumnation and an unusual atmosphere control.

Thursday, May 18 (9:00 a.m.) Pratt & Whitney Machine Tool Company, West Hartford. Tickets will cost $.75 per person. This company manufactures a wide variety of numerically controlled machine tools. Complementing the industrial control technical session of the previous day, the machines and equipment will illustrate the principles previously discussed.

Thursday, May 18 (1:45 p.m.) The Connecticut Light and Power Company's Dispatch Center, Southington. Tickets will

cost $2.50 per person. The company's underground electric dispatching center is designed to resist radioactive fallout in the event of nuclear warfare. The requirements for a building of this type result in many unusual problems which will be explained by company engineers during the visit. Special features are a desired generation computer, automatic load dispatching, utilizing microwave transmission as well as line carrier, various types of telemetering and monitoring, and completely air conditioned underground working and living quarters.

Thursday, May 18 (1:45 p.m.) New Haven Redevelopment, Tickets will cost $1.50 per person. A tour of the much publicized New Haven area in a bus equipped with a loud speaker for a commentator to explain the construction work in progress and completed. The tour will stop at the SNET Company auditorium for a presentation, with slides, by Eben Haskell, Floyd Buck, and Marvin McCoy of the United Illuminating Company on the scope of the redevelopment, with emphasis on the problems of power supply.

Friday, May 19 (9:00 a.m.) Southern New England Telephone Company TJ Microwave System. Tickets will cost $1.75 per person. This is a new and unusual application to avoid the need for high towers to accomplish transmission around obstacles. Telephone Company engineers will be present at both locations to discuss the operation of the system, together with some of the construction and alignment problems that were encountered, and to answer any questions.

Friday, May 19 (9:00 a.m.) Combustion Engineering, Bloomfield. Tickets will cost $1.00 per person. The inspection trip will include two reactor cores under test and prototype model of boiling water reactor. Also on the tour will be an inspection trip to see the materials development laboratory and its equipment.

The tentative technical program follows:

Technical Program

Wednesday, May 17

9:30 a.m. Sessions

Industrial Control

Presiding: E. E. Kirkham, Pratt & Whitney Co.

Industrial Digital Regulators. *R. R. Potts*, Reliance Elec. and Engineering Co.

The Rebirth of Numerical Contouring. *John Dutcher*, General Elec. Co.

Digital Numerical Machine Tool Controls. *N. L. Caban*, Westinghouse Elec. Corp.

Measurement of Loop Gain in a Carrier Servo System. *J. E. Shea*, Perkin-Elmer Corp.

Power Systems Distribution

Presiding: T. R. Macon, General Elec. Co.

Pole Top Design for 23-Kv Distribution. *S. R. Gilligan*, Hartford Elec. Light Co.

25-Kv Distribution—Design and Operating Experience. *P. H. Morris*, Cape & Vineyard Elec. Co.

A Systematic Approach to Preparing Street Light Surveys. *R. H. Chase*, Hartford Elec. Light Co.

2:00 p.m. Sessions

Industrial Control

Presiding: D. Willard, Pratt & Whitney Aircraft

The NOR Box and Its Application. *R. F. Anderson*, Pratt & Whitney Co.

Synthesis with Exclusive-OR Functions. *R. A. D'Antonio*, IBM Corp.

Characteristics of a Synchronous Inductor Motor. *A. E. Snowden, E. Madsen*, Superior Elec. Co.

Hysteresis Scope—Magnetic Material Testing. *R. S. Lundin*, General Time Corp.

Conduction & Grid Current Effects on Thyratron Motor Control & Relay Circuits. *E. F. Nowak*, Pratt & Whitney Co.

Power Systems Distribution

Presiding: C. L. Gamble, General Elec. Co.

Low-Voltage Network Problems Solved by a Digital Computer. *C. A. Jacobson*, Western Mass. Elec. Co.

Computer Analysis of 32-Step Regulator Performance. *M. W. Gangel, W. W. Green*, General Elec. Co.

Economics of Secondary Capacitors in Distribution Conversion Areas. *V. P. Juselis*, Hartford Elec. Light Co.

Estimating the Economical Power Factor Based on Incremental Loss Reduction. *J. Sainz*, General Elec. Co.

Power Generation

Presiding: R. P. Cormier, Conn. Light and Power Co.

Peaking with Diesels by Remote Control. *J. D. Waddell*, Maine Public Service Co.

Direct Conversion of Energy—MHD. *G. Lanza*, Northeastern Univ.

A Large Volume 55,000-Gauss Magnetic Field System for Thermonuclear Research. *C. W. Bushnell*, Allis-Chalmers Mfg. Co., C-Stellerator Associates

Pumped Storage—A New Power Source. *T. F. Armbruster*, Allis-Chalmers Mfg. Co.

Considerations in the Economics of Electric Hydro Design. *R. L. Bean*, Central Main Power Co.

Thursday, May 18

9:00 a.m. Sessions

Communications

Presiding: R. A. Gogolen, Southern New England Telephone Co.

A New Selective Calling System for Mobile Radio. *D. M. Morton*, Hartford Elec. Light Co.

Touch Tone Telephoning. *W. L. Kimmich, Jr.*, Southern New England Telephone Co.

Mechanization of Equipment Ordering. *R. J. Gray*, New England Tel. & Tel.

Loop Around Transmission Test Circuit. *F. O. Richardson, J. J. Clark*, New England Tel. & Tel.

Space Heating

Presiding: F. W. Buck, United Illum. Co.

Distribution System Design to Supply Electric House Heating Loads in New England. *K. W. Proctor*, Worcester County Elec. Co.

Determination of Space Heating Load Characteristics. *J. W. Megley*, Boston Edison Co.

Description and Appraisal of Available Space Heating Equipment. *J. M. Turnbull*, Western Mass. Elec. Co.

Electric Space Heating of a Utility Service Center. *R. P. Werner*, Hartford Elec. Light Co.

Power Systems Engineering

Presiding: R. J. Nolte, L. R. Valonen, Westinghouse Elec. Corp.

Redevelopment and the Utility. *J. I. Sendlein*, United Illum. Co.

A Co-ordinated Approach to Spinning Reserve in New England. *C. P. Corey*, New England Power Co.; *J. M. Schamberger*, Conn. Light & Power Co.; *D. Z. Stremlau*, Conn. Valley Power Exchange; *B. H. Weiner*, Boston Edison Co.

Co-ordinated System Planning—A Multi-Company Approach. *A. W. Barstow*, Western Mass. Elec. Co.; *H. H. Mochon, Jr.*, Hartford Elec. Light Co.; *G. W. Sampson*, Hartford Elec. Light Co.; *A. P. Sternberg*, Conn. Light & Power Co.; *P. J. Sullivan*, United Illum. Co.

A Capacity and Production Cost Computer Program for a Hydro-Thermal System. *A. W. Barstow*, Western Mass. Elec. Co.; *W. H. Ferguson*, Westinghouse Elec. Corp.; *H. H. Mochon, Jr.*, Hartford Elec. Light Co.; *G. W. Sampson*, Hartford Elec. Light Co.; *A. P. Sternberg*, Conn. Light & Power Co.; *P. J. Sullivan*, United Illum. Co.; *L. R. Valonen*, Westinghouse Elec. Corp.

2:00 p.m. Sessions

Insulated Conductors

Presiding: F. H. Linsley, Hartford Elec. Light Co.

Cables for Underground Residential Distribution. *B. J. Mulvey*, General Elec. Co.

Varnished Dacron Glass Insulated Cable. *S. Zysk*, General Elec. Co.

Calculation of Circulating Current Loss in Structural Metal. *V. S. McFarlin*, Boston Edison Co.

Hydraulics of Boston Edison—Brighton-to-Baker 115-Kv Pipe-Type Cable Line. *K. J. Bechet*, Boston Edison Co.

Electrolysis Problems on Cable Sheaths. *A. W. Bachelder*, Southern New England Telephone Co.

Communications

Presiding: L. A. Vocelli, Southern New England Telephone Co.

Supervisor's Centralized Answering Service—#3, #3C, #3CL Switchboards. *G. J. Grafton, J. G. Stephens*, New England Tel. & Tel.

Bellboy Signaling Service. *T. T. Pettingell, Jr.*, New England Tel. & Tel. Co.

Communication Systems for Centralized Data Processing. *L. W. Kirkland, Jr.*, New England Tel. & Tel. Co.

Light Route Microwave Radio System for Southern New England Telephone Company Service in Conn. *J. F. Cannon*, Southern New England Telephone Co.

Orientation of Passive Microwave Reflectors. *D. E. Karrmann*, Southern New England Telephone Co.

Power System Relaying

Presiding: S. H. Law, Western Mass. Elec. Co.

Backup Protection for Ring Bus. *E. P. Barry*, Hartford Elec. Light Co.

Relaying Philosophy at Yankee. *H. Goodrich*, New England Elec. Service.

Relay Protection Philosophies in the Hartford Electric Light Company. *W. F. Fee*, Hartford Elec. Light Co.

Protective Relaying at EHV. *J. Berdy, C. B. Lindh*, General Elec. Co.; *N. Engebretson*, Western Mass. Elec. Co.

Friday, May 19

9:00 a.m. Sessions

Miniaturization and Instrumentation

Presiding: E. S. Raila, Burndy Corp.

Application of a Magnetic Tube in the Design of an Instrumentation Motor. *C. M. Larime*, Dictaphone Corp.

Laminated Circuits. *E. A. Bolton*, Vitramon Corp.

Lack of Sufficient Data and Specifications Covering Small Electrical Conductors. *J. D. Anderson*, Burndy Corp.

Methods of Analysis of Complex Systems. *L. Dolansky*, Northeastern Univ.

Power Systems Transmission

Presiding: T. R. Macon, General Elec. Co.

Design and Construction of 115-Kv Transmission Line Through Built Up City Area of Bridgeport, Conn. *A. F. Sedgwick*, United Illum. Co.

(Continued on p. 287)

AIEE Future Meetings

South East District Meeting*
Jung Hotel
New Orleans, La.
April 5-7, 1961

Rubber and Plastics Industries Conference*[1]
Sheraton Hotel
Akron, Ohio
April 10-11, 1961

Materials Handling Conference*[1]
Pick-Congress Hotel
Chicago, Ill.
April 11-12, 1961

Electric Heating Conference*[1]
Sheraton-Lincoln Hotel
Indianapolis, Ind.
April 11-12, 1961

Extra High Voltage Cable Conference*[1]
Mark Twain Hotel
Elmira, N. Y.
April 11-13, 1961

AIEE-AWS Electric Welding Conference*
Commodore Hotel
New York, N. Y.
April 17-21, 1961

Cement Industry Conference*
Sheraton-Cadillac Hotel
Detroit, Mich.
April 18-20, 1961

Great Lakes District Meeting*
Hotel Pick-Nicolett
Minneapolis, Minn.
April 19-21, 1961

AIEE-IRE Biomedical Engineering Symposium*
El Cortez Hotel
San Diego, Calif.
April 20-21, 1961

Joint Rural Electrification and Appliance Conference*
Kentucky Hotel
Louisville, Ky.
May 1-3, 1961

AIEE-IRE-EIA-WCEMA Electronic Components Conference*
Jack Tar Hotel
San Francisco, Calif.
May 2-4, 1961

Spring Textile Conference*
Heart of Atlanta Motel
Atlanta, Ga.
May 4-5, 1961

AIEE-IRE-ACM Western Joint Computer Conference*
Ambassador Hotel
Los Angeles, Calif.
May 9-11, 1961

Packaging Industry Conference*
New Orleans House
Swampscott, Mass.
May 15-16, 1961

NOTICE TO AUTHORS

Strict compliance with the "Author's Guide" will save you time, delays, and unnecessary correspondence. For a copy, write to E. C. Day, 33 West 39 St., New York 18, N.Y.

North Eastern District Meeting*
Statler Hotel
Hartford, Conn.
May 17-19, 1961

AIEE-ASME Railroad Conference*
Engineers Club
Cleveland, Ohio
May 18-19, 1961

AIEE-IRE Globe-Communication V Conference*[2]
Sherman Hotel
Chicago, Ill.
May 22-24, 1961

AIEE-IRE-ISA-IAS-ARS National Telemetering Conference*[2]
Sheraton Towers
Chicago, Ill.
May 22-24, 1961

Fractional Horsepower Motors Conference*
Engineers Club of Dayton
Dayton, Ohio
May 23, 1961

Summer General Meeting
Cornell University
Ithaca, N. Y.
June 18-23, 1961
(Final date for †TP—closed, ‡CP Syn.—closed CPMs—Apr. 14)

Pulp and Paper Conference
University of Western Michigan
Kalamazoo, Mich.
June 21-23, 1961
(Final date for †TP—closed, ‡CP Syn.—Apr. 7, CPMs—Apr. 17)

Aero-Space Transportation Conference
Benjamin Franklin Hotel
Philadelphia, Pa.
June 26-30, 1961
(Final date for †TP—closed, ‡CP Syn.—Apr. 12, CPMs—Apr. 21)

AIEE-AIChE-ASME-IRE-ISA Joint Automatic Control Conference
University of Colorado
Boulder, Colo.
June 28-30, 1961
(Final date for †TP—closed, ‡CP Syn.—Apr. 14, CPMs—Apr. 24)

JECM&B-IFME International Conference on Medical Electronics
Waldorf-Astoria Hotel
New York, N. Y.
July 16-21, 1961
(Final date for †TP—Apr. 18, ‡CP Syn.—May 4, CPMs—May 15)

Pacific General Meeting
Hotel Utah
Salt Lake City, Utah
August 23-25, 1961
(Final date for †TP—May 25, ‡CP Syn.—June 5, CPMs—June 19)

AIEE-IRE-ISA Joint Nuclear Instrumentation Conference
North Carolina State College
Raleigh, N. C.
September 6-8, 1961
(Final date for †TP—June 8, ‡CP Syn.—June 23, CPMs—July 3)

AIEE-ASME Engineering Management Conference
Hotel Roosevelt
New York, N. Y.
September 14-15, 1961
(Final date for †TP—June 16, ‡CP Syn.—June 30, CPMs—July 11)

Petroleum Industry Conference
Jung Hotel
New Orleans, La.
September 17-20, 1961
(Final date for †TP—June 19, ‡CP Syn.—July 5, CPMs—July 14)

AIEE-IRE Industrial Electronics Conference
Bradford Hotel
Boston, Mass.
September 20-21, 1961
(Final date for †TP—June 22, ‡CP Syn.—July 7, CPMs—July 17)

AIEE-ASME National Power Conference
St. Francis Hotel
San Francisco, Calif.
September 24-27, 1961
(Final date for †TP—June 26, ‡CP Syn.—July 11, CPMs—July 21)

Fall General Meeting
Statler-Hilton Hotel
Detroit, Mich.
October 15-20, 1961
(Final date for †TP—June 14, ‡CP Syn.—July 27, CPMs—Aug. 11)

Winter General Meeting
Hotel Statler
New York, N. Y.
January 28-February 2, 1962
(Final date for †TP—Oct. 30, ‡CP Syn.—Nov. 9, CPMs—Nov. 24)

*Final date for submitting papers—closed
[1]No conflict in subject matter
[2]Planned to coincide

†TP—Transactions Paper
‡CP Syn.—Conference Synopsis
CPMs—Conference Manuscript
DPMs—District Manuscript
(District Paper Synopses should be directed to the District Meeting Committee)

Schedule of AIEE General and District Meetings

MEETING	DESIGNATION	NAME OF MEETING	CONVENTIONAL SCHEDULE	1961			1962			1963			1964			1965			INVITATIONS	
				DATE	LOCATION	PAPER CLOSING	DATE	LOCATION	PAPER CLOSING	DATE	LOCATION	PAPER CLOSING	DATE	LOCATION	PAPER CLOSING	DATE	LOCATION	PAPER CLOSING	DATE	LOCATION
GENERAL	WG	WINTER	FEB. 1ST WEEK	JAN. 29 FEB. 3	NEW YORK, N.Y.	NOV. 1 1960	JAN. 28 FEB. 2	NEW YORK, N.Y.	OCT. 30 1961	JAN. 27 FEB. 1	NEW YORK, N.Y.	OCT. 29 1962	FEB. 2-7	NEW YORK, N.Y.	NOV. 4 1963	JAN. 31 FEB. 5	NEW YORK, N.Y.	NOV. 2 1964		
	SG	SUMMER	JUNE 3RD 4TH WEEK	JUNE 18-23	ITHACA, N.Y.	MAR. 20 1961	JUNE 17-22	DENVER, COLO.	MAR. 19 1962	JUNE 16-21	TORONTO, CANADA	MAR. 18	JUNE 21-26	LOS ANGELES, CALIF.	MAR. 23	JUNE 20-25	MIAMI, FLA.	MAR. 22	67 68	PORTLAND, OREGON MONTREAL, CANADA
	PG	PACIFIC	AUG.	AUG. 23-25	SALT LAKE CITY, UTAH	MAY 25 1961				AUG. 20-23	SPOKANE, WASH.	MAY 23	JUNE 21-26	LOS ANGELES, CALIF.	MAR. 23				65 66 67	VICTORIA, B.C. PHOENIX, ARIZ. PORTLAND, ORE.
	FG	FALL	OCT.	OCT. 15-20	DETROIT, MICH.	JUNE 14 1961	OCT. 7-12	CHICAGO, ILL.	JUNE 8	OCT. 6-11	CHICAGO, ILL.	JUNE 7		HOUSTON, TEXAS			CHICAGO, ILL.		66	CHICAGO, ILL.
DISTRICT	D1	EMPIRE	EARLY MAY				MAY 14-16	ERIE, PA. JOINT WITH D11 & D14	FEB. 13											
	D2	MIDDLE EASTERN	MAY				MAY 7-9	WILMINGTON, DEL.	FEB. 8											
	D4	SOUTH EAST	LATE MAR. EARLY APR.	APR. 5-7	NEW ORLEANS, LA.	JAN. 2 1961				APR. 24-26	RICHMOND, VA.	JAN. 24								
	D5	GREAT LAKES	LATE APR.	APR. 19-21	MINNEAPOLIS, MINN.	JAN. 19 1961	APR. 18-20	FORT WAYNE, IND.	JAN. 19 1962	MAY 1-3	QUAD-CITIES	JAN. 31	APR. 22-24	PEORIA, ILL.	JAN. 23					
	D7	MID-AMERICA	LATE MAR. EARLY APR.				APR. 30 MAY 2	ST. LOUIS, MO.	JAN. 30											
	D11	EAST CENTRAL	EARLY MAY				MAY 14-16	ERIE, PA. JOINT WITH D1 & D14	FEB. 13	MAY 8-10	TOLEDO, OHIO JOINT WITH D14	FEB. 7		PITTSBURGH, PA. JOINT WITH D14			CINCINNATI OR COLUMBUS, O. WITH D14		66	DAYTON, OHIO
	D12	NORTH EASTERN	LATE APR. EARLY MAY	MAY 17-19	HARTFORD, CONN.	FEB. 16 1961	MAY 9-11	BOSTON, MASS.	FEB. 8 1962	MAY 14-17	PORTSMOUTH, N.H.	FEB. 13	APR. 27-29	WORCESTER, MASS.	JAN 28	APR. 26-28	PITTSFIELD, MASS	JAN. 26	APR. 25-27 66	SPRINGFIELD, MASS.
	D13	SOUTH CENTRAL	LATE MAR. EARLY APR.	APR. 5-7	JOINT WITH D4 NEW ORLEANS, LA.	JAN. 2 1961	APR. 4-6	MEMPHIS, TENN.	JAN 4 1962	APR. 24-26	JOINT WITH D4 RICHMOND, VA.	JAN. 24	APR. 1-3	BIRMINGHAM, ALA.	JAN. 2					
	D14	ALLEGHENY-OHIO VALLEY	APR. OR MAY				MAY 14-15	ERIE, PA. JOINT WITH D1 & D11	FEB. 13	MAY 8-10	TOLEDO, OHIO JOINT WITH D11	FEB. 7		PITTSBURGH, PA. JOINT WITH D11			CINCINNATI OR COLUMBUS, O. WITH D11			
EASTER				APRIL 2			APRIL 22			APRIL 14			MARCH 29			APRIL 18				

Schedule of Special Technical Conferences

1961	Conference and Location	Sponsors
April 10-11	Rubber and Plastics Industries—Sheraton Hotel, Akron, Ohio	AIEE
April 11-12	Materials Handling—Pick-Congress Hotel, Chicago, Ill.	AIEE
April 11-12	Electric Heating—Sheraton-Lincoln Hotel, Indianapolis, Ind.	AIEE
April 11-13	Extra High Voltage Cable—Mark Twain Hotel, Elmira, N. Y.	AIEE
April 17-21	Electric Welding—Commodore Hotel, New York, N. Y.	AIEE-AWS
April 18-20	Cement Industry—Sheraton-Cadillac Hotel, Detroit, Mich.	AIEE
April 20-21	Railroad—Sir Francis Drake Hotel, San Francisco, Calif.	AIEE-ASME
May 1-3	Joint Rural Electrification and Appliance—Kentucky Hotel, Louisville, Ky.	AIEE
May 2-4	Electronic Components—Jack Tar Hotel, San Francisco, Calif.	AIEE-IRE-EIA-WCEMA
May 4-5	Spring Textile—Heart of Atlanta Motel, Atlanta, Ga.	AIEE
May 9-11	Western Joint Computer—Ambassador Hotel, Los Angeles, Calif.	AIEE-IRE-ACM
May 15-16	Packaging Industry—New Ocean House, Swampscott, Mass.	AIEE
May 22-24	Globe-Communication V—Sherman Hotel, Chicago, Ill.	AIEE-IRE
May 22-24	National Telemetering—Sheraton Towers, Chicago, Ill.	AIEE-IRE-ISA-IAS-ARS
May 23	Fractional Horsepower Motors—Engineers Club of Dayton, Dayton, Ohio	AIEE
June 21-23	Pulp and Paper—University of Western Michigan, Kalamazoo, Mich.	AIEE

(Continued from p. 284)

Service Experience with Constant-Pressure Oil Preservation System. *G. G. Doucette*, General Elec. Co.

Phase-to-Phase Switching Surges on Line Energization. *I. B. Johnson, R. F. Silva, D. D. Wilson*, General Elec. Co.

Short Duration Current Capabilities Overhead ACSR Lines. *H. W. Lis, F. R. Longley*, Western Mass. Elec. Co.

2:00 p.m. Sessions

Electric Process Heating

Presiding: J. H. Ahrens, Hartford Elec. Light Co.

High-Temperature Radiant Heating. *R. W. Jeffrey*, Fostoria Corp.

New High-Frequency Resistance Welding Applications. *W. C. Rudd*, New Rochelle Thermatool Corp.

Application of the Fluidized Bed in Industrial Heating. *K. F. Henrich*, General Elec. Co.

All Electric Furnace Line for Bright Annealing Stainless Steel Strip. *W. Muirhead*, General Elec. Co.; *G. A. Smith*, Wallingford Steel Co.

Computers

Presiding: L. R. Jones, Dictaphone Corp.

Seminar on Computer Applications. *H. Fokens*, National Cash Register Co.; *E. Seaman*, Dictaphone Corp.; *O. J. Black*, IBM Corp.

Computer Solutions to Nuclear Icebreaker Propulsion Problems. *G. F. Rogers*, M. B. Electronics Corp.

THE Northern States Power System Dispatching Center will be viewed during the Great Lakes District Meeting. This photo shows the system telemetering in the background and a portion of the load frequency control equipment.

Don Berg

Textile Industry Conference Scheduled for May 4-5 in Atlanta

The 1961 Conference on Electrical Applications for the Textile Industry will be held on May 4-5, 1961, at the Heart of Atlanta Motel, in Atlanta, Ga. The tentative program of conference papers follows:

New Products Symposium

Guardister Thermister Motor Protection. *W. S. Hines*, Westinghouse Elec. Corp.

Thermo-Tector Motor Protection. Stato-trol Silicon Controlled Rectifier Drives. *R. R. Prechter*, General Elec. Co.

New Product from a representative of the Allis-Chalmers Mfg. Co.

Syncro Regulators for Speed and Draw Control. *R. T. Campbell*, Louis Allis Co.

Methods Used in Locating System Grounds. *J. R. Torrence*, Dan River Mills

Fundamentals of Digital Computers. *J. L. Richardson*, Minneapolis-Honeywell Co.

Textile Applications of Digital Computers. *J. H. Reynolds*, Celanese Fiber Co.

Report of Standards Panel. *Swaffield Cowan*, Factory Insurance Assn.

Final Report of Surface Temperature Study. *R. E. Parker*, General Elec. Co.

Characteristics of Nonexcited Synchronous Motors.

Reluctance Type. *B. R. Becker*, Louis Allis Co.

Permanent Magnet Type. *C. D. Beck*, General Elec. Co.

Hysteresis Type. *C. G. Helmick*, Westinghouse Elec. Co.

Application of Nonexcited Synchronous Motors. *E. W. Davis*, E. I. Dupont de Nemours & Co.

In addition to these interesting and informative papers, the conference will have a luncheon, social hour, and a banquet.

76 Technical Papers Are Listed for AIEE Great Lakes District Meeting

OUTSTANDING speakers with wide geographic representation will present 76 technical papers in 19 sessions at the AIEE Great Lakes District Meeting on April 19-21 at the Pick-Nicollet Hotel, Minneapolis, Minn.

Ten informative inspection tours, closely co-ordinated with the technical papers, have been arranged for both technical and general interest.

The General Sessions will take place at the noon luncheons each day in the Walnut Room, with programs as follows: C. H. Linder, AIEE president, will be the main speaker on Wednesday. Dr. John Kelly of Westinghouse Electric Corporation will address the Thursday luncheon on the subject, "What's New in Research." On Friday, the principal feature of the program will be the presentation of the Student Paper Competition awards.

Technical Sessions

The program schedule of 17 different subject headings in 19 sessions fills all 3 days. The technical paper presentations range in background from d-c to 60 cycles to megacycles, from electronics to nucleonics, from applied science and engineering to education, from advanced control and communication theory to research. A special attempt has been made to arrange the paper presentations to precede related tours to outstanding laboratories, plants, and factories located in the Twin Cities metropolitan area.

Student Paper Competition

On Thursday, April 21, the Great Lakes District Student Paper Competition will be held in the Hotel Pick-Nicollet Aquatennial Room, with entries from the 17 Student Branches. The first place winner will receive a $25 award and have the distinction of representing the District at the Summer General Meeting at Cornell University at Ithaca, N.Y. The second place winner will receive a $25 award and the third place winner $15. Presentation of these awards will be a feature of the Friday noon luncheon.

Registration

Facilities for registration will be located on the mezzanine floor lobby of the Pick-Nicollet Hotel. For those arriving on April 18, the registration desk will be open at 5:00 p.m.-9:00 p.m. During the meeting, registration hours will be during 8:15 a.m.-5:00 p.m. On the final day, Friday, April 21, the registration desk will close at 12:00 noon.

Registration fees will be: members, $4; nonmembers, $7; student members, no fee, and wives of registrants, $2.

Those attending are advised to return advance registration cards early, with an indication of the activities each plans to attend. This will give the committees an opportunity to make adequate provisions for all affairs. Money should not be sent with registration. It is recommended that

immediately upon completing registration at the hotel, the participants procure tickets for inspection trips, luncheons, buffet dinner, theater party, banquet, and ladies activities.

Hotel Reservations

A block of rooms has been set aside at the Pick-Nicollet Hotel to accommodate those planning to attend the meeting. The hotel reservation card should be completed and returned promptly to the Pick-Nicollet Hotel. The hotel will arrange for any alternate rooms should their facilities be completely sold out. Rates per day are as follows:

Single Room (one person) ..	$ 9.00 to $13.50
Double Room—Double Bed (two persons)	$11.50 to $16.00
Double Room—Twin Beds (two persons)	$12.50 to $17.00
Suites (two and three rooms)	$27.50 to $70.00

Ladies' Program

An entertainment program has been planned for the ladies.

On Wednesday morning at 9:45 a.m., a guided tour of Southdale will show "behind the scenes" features of this modern unique shopping center with 75 stores and shops within a landscaped, air-conditioned area under one roof. Lunch will be held in one of the tea rooms at 11:45 a.m.

A guided tour of the American-Swedish Institute has been scheduled for Thursday at 1:45 p.m.

Ladies' coffee hours have been arranged for Thursday and Friday mornings at 9:30 a.m. in the Arrowhead Room of the Pick-Nicollet Hotel.

Social Activities

The banquet will be held Thursday at 7:00 p.m. in the Walnut Room, after the "Dutch treat" Hospitality Hour at 6:00 p.m. The popular Schiek's Sextette with orchestra will entertain with songs and music from Broadway shows. Dress will be informal at the banquet, and the price per person will be $6.50.

Inspection Trips

Wednesday, April 19 (2:00 p.m.) Lightning & Transients Research Institute and Northern States Power Computer Center. Demonstrations of high-voltage and high-current discharges will show the latest lightning protection techniques for jet aircraft. At the computer center, two large computers will be in operation. The cost of this trip is $2 per person.

Wednesday, April 19 (2:00 p.m.) Minnesota Mining & Manufacturing Company. Electrical Products Laboratory. The tour will cover the facilities of the company's electrical products and magnetic products divisions, the laboratories where research, product development, engineering, and related activities in areas of primary interest to the AIEE are concerned. Each person taking the trip will be charged $2.25.

Wednesday, April 19 (8:00 p.m.) Northwestern Bell Telephone Company. Long Lines Division. The tour will be conducted at the telephone company's office building six blocks from the hotel. A charge of 25¢ will be made to each attending the tour.

Thursday, April 20 (8:30 a.m.) Electric Machinery Manufacturing Company and Control Corporation. A trip through the Central Avenue plant of the Electric Machinery Manufacturing Company will cover all steps in the manufacture, assembly, and testing of both large and small rotating machines. At the Control Corporation, across the street from Electric Machinery, the group will see supervisory control equipment in various stages of construction. The cost of this trip will be $2 per person.

Thursday, April 20 (9:00 a.m.) Control Data Corporation. This tour will be preceded by a general assembly for a chalk-talk, plus demonstration on general information about the operation and various uses of the computer. Later, the group will be divided into four or five smaller groups to observe several items in production. The cost of this trip will be $1.50 per person.

Thursday, April 20 (2:00 p.m.) Northern States Power Company—Southtown Substation, Black Dog Steam Plant. Southtown Substation is a major transmission substation supplying a portion of the South Minneapolis load. Black Dog Steam Plant, located on the Minnesota River, is the second largest generating station on the Northern States Power Company system. The cost of this tour is $2 per person.

Thursday, April 20 (2:00 p.m.) Remington Rand Univac. A film, "Introduction to Digital Computers," will be followed by inspection of the Solid-State *80* Computer, Univac *490* Real Time Computing System, Advanced Core Memory Section, Thin Film Memory Computer, and Nike Zeus Computer Assembly Area. Each person attending the tour will be charged $1.50.

Thursday, April 20 (8:00 p.m.) Northern States Power Company—System Dispatching Office. The nerve center of the company is the System Dispatching Office where a great many system-wide operations originate or are performed by the System Operations Staff and dispatchers. A charge of 25¢ will be made to each person attending this trip.

Friday, April 21 (9:00 a.m.) Northern States Power Company Testing Laboratory. A visit to the laboratory offers an opportunity to observe a wide variety of chemical and physical tests of materials. The cost for this tour is $2 per person.

Friday, April 21 (9:00 a.m.) Minneapolis-Honeywell. The Temperature Control Division will show some of its Main Plant facilities. The Chemical and Metallurgical Laboratory will show uses of various electronic equipment for material analysis. The cost of this tour will be $2 per person.

FINISHING TOUCHES are being put on a control panel used with a motor generator set being built for the strategic air command. This skilled wire man is shown at work at the Electric Machinery Manufacturing Company, which will be toured during the Great Lakes District Meeting.

Technical Program Given

The tentative technical program* for the meeting follows:

Wednesday, April 19

9:00 a.m. Science and Research

Presiding: R. P. Featherstone, Univ. of Minnesota Linac Lab.

The Biomedical Electronics Program at I.S.U. *V. W. Bolie, W. B. Boast, Robert Getty, M. J. Swenson,* Iowa State Univ.

New Goals in Plasma Energy. *E. H. Brill,* Allis-Chalmers Mfg. Co.

The Physical Nature of Ball Lightning. *E. L. Hill,* Univ. of Minnesota, Lightning & Transients Research Inst.

A New Technique for Simultaneous Measurement of Thermoelectric Material Properties as Functions of Temperature. *T. L. Nystrom, J. D. Richards,* Minnesota Mining and Mfg. Co.

Sea-Going Lightning Generator. *M. M. Newman, J. R. Stahmann, J. D. Robb,* Lightning & Transients Research Inst.

*Most of the papers listed are author-printed District Papers, with exceptions where a Conference Paper number is given.

9:30 a.m. Insulating Materials and Systems

Presiding: W. M. Hanson, Minnesota Mining and Mfg. Co.

Silicone Rubber Insulating Systems. *R. J. Potts*, Allis-Chalmers Mfg. Co.

Powdered Epoxy Resins for Electrical Insulating Applications. *Rupert Strobel*, Minnesota Mining and Mfg. Co.

Low and Medium Voltage Cable Coverings. *H. C. Witthoft*, Anaconda Wire & Cable Co.

Voltage Endurance of Insulating Materials. *Murray Oliphant*, Minnesota Mining and Mfg. Co.

9:30 a.m. Digital Data Processing Systems

Presiding: James Alman, Univac Div. of Sperry Rand Corp.

Engineering Data Processing—1970. *J. S. Fouch*, IBM.

The Satellite Computer System. *Alfred Christofferson, Jr.*, Control Data Corp.

Space-Age Digital Computers-Components and Capabilities. *A. J. Khambata, R. A. Urban*, Univac Div. of Sperry Rand Corp.

2:00 p.m. Education

Presiding: H. E. Hartig, Univ. of Minnesota

The Harmonic Demonstrator Using Pulse Techniques. *Gerold Neudeck*, Univ. of North Dakota

A Professional Guidance Program for High School Science Students. *C. D. Motchenbacher*, Minneapolis Honeywell

Poor Teachers. *E. M. Anderson*, North Dakota State College

Electric Machinery Instruction—Required or Optional? *L. F. Stauder*, Univ. of Notre Dame

Engineering Education Beyond the Bachelor's Level. *R. F. Lambert*, Univ. of Minnesota

2:00 p.m. Instrumentation & Data Logging

Presiding: R. W. Pinkney, Pinkney & Hine Co.

Digital Data Acquisition System for Electric Utilities. *Herman Wittenberg, J. H. Baker*, Control Corp.

CP-60-1233. Factors in Design and Application of Digital Telemetering. *E. W. Head*, Control Corp.

Instruments and their Calibration. *M. E. Todd, M. C. Hughes*, Instrumentation Services, Inc.

Solid-State Analog FM Telemetering System. *S. Hille*, Control Corp.

2:00 p.m. Rotating Machinery

Presiding: R. L. Fillmore, Minneapolis Honeywell

Static, Electronic, and Rotating Excitation Systems for Turbine Generators. *L. M. Domeratzky, M. Temoshok*, General Elec. Co.

Applications of High-Frequency Power. *G. W. Sangster*, Elec. Machinery Mfg. Co.

Magnaflow and Rectiflow Adjustable Speed Drives as Applied to Pumping and Other Applications. *R. P. Bleikamp*, Westinghouse Elec. Corp.

Application and Performance of a Static-Excited A-C Generator with No Compounding or Field Flashing Devices. *H. E. Jorgenson, G. T. Stromme*, Onan Div. of Studebaker-Packard

Thursday, April 20

9:00 a.m. Communications

Presiding: A. J. Hendry, Northern Pacific Rwy. Co.

Personal Radio Systems & Applications. *L. Weddig*, Motorola, Inc.

Broad Band Impedance Matching by Applying a Tybecheff Approximation to Discrete Frequency Data. *William Bares*, Univ. of North Dakota

Reliability of Communication Facilities. *J. S. Oakes, F. S. Hird*, Northwestern Bell Telephone Co.

The Installation of a Television Station, KCND-TV, for Pembina, N. Dak. *C. J. Thomforde*, Univ. of North Dakota

9:00 a.m. Power System Engineering

Presiding: J. F. Rowe, Minnesota Power & Light Co.

Automation of System Operation. *L. K. Kirchmayer, H. J. Fiedler*, General Elec. Co.

Evaluation of Tie Capacity between Pools or Systems. *H. E. Lokay, M. S. Schultz*, Westinghouse Elec. Corp.

An Operational Cost Simulator. *J. B. Vieaux*, IBM

9:00 a.m. Transmission and Distribution

Presiding: M. W. Anderson, Northern States Power Co.

Contributions of Standard Suspension Mountings to Cost of HV and EHV Lines. *W. H. Burleson, R. W. Harmon*, Ohio Brass Co.

Fault Study in Power Systems by Tensor Procedures in Symmetrical Component Analysis. *G. L. Kang*, Stromberg-Carlson Co.; *T. J. Higgins*, Univ. of Wisconsin

Effect of Lightning on Transmission and Distribution Structures. *E. W. Christoferson, T. S. Jepson*, Northern States Power Co.; *J. A. Robb*, Lightning & Transients Research Inst.

Street Lighting Practices. *R. E. Warren*, Northern States Power Co.

2:00 p.m. Industrial Power Systems

Presiding: W. G. Brierley, Automatic Control Co.

Directional Overcurrent Relays on Industrial Network Type Systems. *A. H. Knable*, Allis-Chalmers Mfg. Co.

Comparing Computer Calculated Horsepower Requirements with Field Test Performance. *R. G. Lynn*, American Hoist & Derrick Co.

Serving Large Downtown Buildings. *T. G. A. Sillers, A. E. Kilgour, L. E. Whitsitt*, Allis-Chalmers Mfg. Co.

Application of Circuit Breakers with Symmetrical Ratings in Industrial Plants. *P. L. Camp, J. D. Wood*, ITE Circuit Breaker Co.

2:00 p.m. Automatic Control Theory

Presiding: Edwin Kinnen, Univ. of Minn.

Describing Function Analysis of a Type-I Control System with a Nonsymmetrical Dead Zone Nonlinearity. *R. P. Langkammer*, A-C Spark Plug Div., General Motors Corp.; *T. J. Higgins*, Univ. of Wisconsin

Learning Model Approach to Self-Evaluation and the Method of Lyapunov. *E. R. Rang, C. W. Johnson*, Minneapolis Honeywell

Error Coefficient Analysis and Synthesis of Digital and Sampled Data Control Systems. *J. F. Spitzer*, IBM; *T. J. Higgins*, Univ. of Wis.

Optimization in a Mean-Square Sense of a Two-Dimensional Sampled-Data System. *C. H. Murrish, T. J. Higgins*, Univ. of Wisconsin

2:00 p.m. Instrumentation

Presiding: R. L. Sell, Telex, Inc.

Semiconductor Strain Gauges. *Don Long, Obert Tufte*, Minneapolis Honeywell

Instrumentation Technique in Magnetic Amplifier Application. *L. A. Gregory*, Magnetic Controls Co.

A Sensitive Displacement Meter Utilizing a Hall Effect Probe. *C. D. Motchenbacher, S. B. Schuldt*, Minneapolis Honeywell

Magnetic Recording. *Charles Robinson*, Maico Electronics, Inc.

Friday, April 21

9:00 a.m. Computing Devices

Presiding: Frank Klauda, IBM

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Integrated Semiconductor Circuits. *W. J. Rydrych*, Univac Div. of Sperry Rand Corp.

Influence of Minor Impurities in Ferromagnetic Films. *R. J. Prosen*, Minneapolis Honeywell

Tolerance Analysis of Tunnel Diode Circuits. *W. R. Raisanen*, Univac Div. of Sperry Rand Corp.

Studies of High Coercivity Electrodeposits. *J. S. Sallo*, Minneapolis Honeywell

9:00 a.m. Nuclear Power

Presiding: E. C. Ward, Northern States Power Co.

Technical and Economic Status of Central Station Pressurized Water Reactors. *W. L. Budge*, Westinghouse Elec. Corp.

Electrical Features of Elk River Nuclear Plant. *L. J. Blasiak*, Allis-Chalmers Mfg. Co.

Control Philosophy for a Boiling Water Reactor with an Internal Nuclear Superheater. *David Crimmins, J. T. Stone*, Allis-Chalmers Mfg. Co.

The Primary Control System for Pathfinder Atomic Power Plant. *D. M. Leppke*, Pioneer Service & Engineering Co.

9:00 a.m. Process Automation Systems

Presiding: W. J. Field, General Magnetics, Inc.

Automation of the Postal System. *H. S. Montgomery*, Cutler Hammer, Inc.

Automatic Directive Systems. *Russell Hedline, Thomas Rauhar, Thomas Stern*, Ramsey Engineering Co.

Computers for On-Line Process Control. *W. C. Tice*, General Elec. Co.

2:00 p.m. Communications

Presiding: H. O. Arneson, Northwestern Bell Telephone Co.

A New Era in Mobile Telephone Systems. *W. G. Pree*, General Elec. Co.

Determination of Subareas of the Parameters of Broad-Band Lines Comprised of Strip Rectangular-Tubular, or Circular-Tubular Conductors. *T. N. Feng*, John Oster Co.; *T. J. Higgins*, Univ. of Wisconsin

CP-61-116. Transmission Aspects of an Integrated Private Line Telephone System. *R. A. Schaefer*, Wisconsin Telephone Co.

Radio Relay Development in Northern Minnesota. *J. C. Barnes, F. S. Hird*, Northwestern Bell Telephone Co.

2:00 p.m. Economic Dispatch of Power Generation

Presiding: F. J. Linder, Dairyland Power Co-op.

Wisconsin Public Service Corp. Experience with Economic Dispatch. *M. A. Peot*, Wisconsin Public Service Co.

Digital Computers as Applied to Unit Commitments. *P. C. McKillop*, IBM

Optimal Unit Selection in Daily Generation Dispatch. *C. A. DeSalvo, K. M. Dale,* Westinghouse Elec. Corp.

Input and Output Techniques for an On-Line Digital Computer Control System. *W. G. Beyer, W. B. Schultz, T. W. Hissey,* Leeds & Northrop Co.

2:00 p.m. Electronic Components

Presiding: A. N. DeSautels, Maico Electronics, Inc.

Microminiaturization. *Joachim Todt,* Maico Electronics, Inc.

Principles and Functions of Cold Cathode Trigger Tubes. *R. G. Johnson,* Minneapolis Honeywell

A High Gain Ceramic Triode for Broad-Band Amplifiers. *J. D. Campbell,* General Elec. Co.

Development of a Microminiature Solid Electrolyte Tantalum Capacitor. *William Balas,* Minneapolis Honeywell

2:00 p.m. Transmission and Distribution

Presiding: C. T. Sickel, Minnesota Power and Light Co.

Automatic VHF Radio Reporting of System Outages. *V. S. Anderson,* Motorola, Inc.

Thermal Upgrading of Power Transformers. *J. H. Carpenter, J. R. Meador,* General Elec. Co.

Distribution Transformer Overload Capacity and Life Expectancy. *A. R. Waehner,* Line Material Industries

A Computer Study of Distribution Transformer and Secondary Arrangements. *R. E. Warren,* Northern States Power Co.

Line and Revenue Loss Due to System Growth. *R. A. Dewberry,* Montana-Dakota Utilities Co.

Progress toward Unity of Engineering Profession Noted

An article which outlines the steps taken toward unity of the engineering profession with the important roles played by the Engineers Joint Council (EJC), the Engineers' Council for Professional Development (ECPD), and the National Society of Professional Engineers (NSPE), entitled "Engineering Unity and ASME Members," by G. B. Warren, past-president of the American Society of Mechanical Engineers (ASME), appears in the March 1961 issue of *Mechanical Engineering,* pp. 30-33.

The article explains the "functional concept" and brings out the need for a unity organization in this rapidly expanding era where the practice of engineering seems to be developing a complexity and overlapping of disciplines. The limitations toward achieving a unity organization due to the tax situation are explained, as well as the four principal reasons which are preventing more complete implementation of unity plans.

In conclusion, the article brings the reader up-to-date by explaining the final action of the Past-President's Task Force on Unity, which recommended that the presidents and vice-presidents of EJC, ECPD, and NSPE be brought together four times per year to better co-ordinate their work and avoid duplication of action and efforts. The author states that this proposal has met with general agreement and meetings have begun.

Lamme Medal 1961 Nominations Due November 1

SPECIAL attention is directed to the fact that the names of Institute members who are considered eligible for the AIEE Lamme Medal to be awarded early in 1962, may be submitted by any member in accordance with section 1 of Article VI of the bylaws of the Lamme Medal Committee as follows:

"The committee shall cause to be published in one or more issues of *Electrical Engineering,* or of its successors each year, preferably including the April issue, a statement regarding the Lamme Medal and an invitation for any member to present to the Secretary of the Professional Development and Recognition Department by November 1, the name of a member as a nominee for the medal, accompanied by a statement of his 'meritorious achievement' and the names of at least three engineers of standing who are familiar with the achievement."

Each nomination should give concisely the specific grounds upon which the award is proposed, and also a complete detailed statement of the achievements of the nominee, to enable the committee to determine its significance as compared with the achievements of other nominees. If the work of the nominee has been of a somewhat general character in co-operation with others, specific information should be given regarding his individual contributions. Names of endorsers should be given as specified in the foregoing quotation.

Article V, section 2, specifies that:

"The committee in making the award shall carefully observe the limitations imposed by Mr. Lamme, that the recipient must have 'shown meritorious achievement in the development of electrical apparatus and machinery.' This shall be taken to mean that the meritorious achievement must be of such character that it has resulted or will result in the production of substantially improved electrical apparatus or machinery. Any work which meets this requirement is admissible whether it be (a) in development of the characteristics of the materials employed; (c) in development of over-all design; or (d) in development in other ways which results in substantial improvement in electrical apparatus or machinery. The words 'electrical apparatus or machinery' shall be taken to indicate discrete and self-contained devices which may or may not include mechanical moving parts without limitation as to the field of application. They shall not be taken to include transmission or distribution systems as a whole, but rather to include the apparatus and machinery that is used in making up such systems."

Conference Papers Open for Discussion

Conference papers listed below have been accepted by AIEE *Transactions* and are now open for written discussion until April 26. Duplicate double-spaced typewritten copies of each discussion should be sent to E. C. Day, Assistant Secretary for Technical Papers, AIEE, 33 W. 39th St., New York 18, N. Y., on or before April 26.

57-791	**Comparison of Steel and Aluminum Subway Cars.** *L. W. Bardsley*
59-645	**Electromagnetic Brake with Controllable Torque.** *C. A. Lister*
59-1191	**Algorithms for Logical Design.** *A. C. Ewig, J. P. Roth, E. G. Wagner*
60-60	**Automatic Logging of AM, FM, and Television Transmitting Station Parameters.** *G. Ehrenberg*
60-193	**Generalized Recurrence Relations in the Analysis of Nonlinear Systems.** *A. A. Wolf*
60-200	**The Determination of the Hysteresis Curve for Thick Tape Codes.** *P. Dentella, E. Della Torre*
60-980	**Considerations in the Design of a Dynamic Control System for the Generalized Chemical Processing Model Considered as a Nonlinear System.** *A. E. Beecher, L. A. Gould*
60-1015	**Neutron and Gamma Irradiation of Some Square-Loop and Microwave Ferrites.** *R. W. Moss, C. F. Kool, M. E. Baldwin*
60-1020	**Problems of Asymptotic Behavior and Stability.** *Lamberto Cesari*
60-1250	**A Speakerphone System for Large Conference Rooms.** *L. R. Huggler*

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A VACATION AT COLLEGE—CORNELL UNIVERSITY
ITHACA, N. Y.—JUNE 18-23

SUMMER GENERAL MEETING

NOTEWORTHY achievement in the engineering profession was recognized during the Winter General Meeting with the presentation of the Mervin J. Kelly Award to Dr. M. J. Kelly (*left*), retired chairman of the board of Bell Telephone Laboratories, Inc., and the Edison Medal to Dr. H. S. Osborne (*right*), consulting engineer, American Telephone & Telegraph Company. AIEE President C. H. Linder (*center*) is shown presenting certificates to both award winners.

Ross Photo

Attendance Exceeds 4,500 Persons at Winter General Meeting in New York

THE AIEE Winter General Meeting, held in New York City, January 29-February 3, 1961, at the Statler-Hilton and Governor Clinton Hotels, was well attended despite heavy snows and extreme cold. Attendance exceeded 4,500. There were 119 technical sessions at which 487 technical papers were presented.

An informal tea was held Sunday afternoon, January 29. Other social events were the smoker on Tuesday evening and the dinner-dance held Thursday evening.

Inspection trips were made to many industrial and engineering sites in the New York area. Included were visits to the Anaconda Wire and Cable Company, the Astoria Generating Station of the Consolidated Edison Company, the Bell Telephone Laboratories' Murray Hill, N. J., branch, the Brookhaven National Laboratory at Upton, N. Y., the Holophane Light and Vision Institute, and the Ford Motor Company's Mahwah, N. J., plant.

President Linder Addresses Meeting

The general session took place on Monday afternoon in the Grand Ballroom of the Statler-Hilton with R. W. Gillette presiding. AIEE President C. H. Linder made a brief address on the subject of "Significant Committee Contributions," and then, together with L. F. Kennedy, chairman of the Prize Awards Committee, presented the AIEE Prize Paper awards. (See photo of prize paper winners on p. 293.)

Hendley Blackmon, chairman, AIEE Nominating Committee, placed in nomination for AIEE president W. H. Chase, vice-president of the Ohio Bell Telephone Company, Cleveland, Ohio. Names of candidates for positions of district vice-presidents, technical vice-presidents, directors-at-large, department directors, and treasurer will be found in the March issue on p. 213.

Presentation of the Mervin J. Kelly Award for outstanding achievement in telecommunications to Dr. M. J. Kelly, retired chairman of the board, Bell Telephone Laboratories, Inc., was made by President Linder and Dr. S. R. Warren Jr., chairman, Recognition Awards Committee. (See pp. 257-60.)

Dr. Kelly, in his acceptance speech, called for a doubling of the nation's expenditures for basic research and a revamping of the present training patterns for scientists and engineers engaged in creative technology. "The portion of the nation's research and development effort devoted to fundamental or basic research is too small," he said. ". . . it is generally accepted that less than 10% of the nation's expenditures is for basic research. Its level should be doubled as rapidly as the required scientists can be trained." He also suggested that, as the nation's basic research expenditures are doubled, those of industry should be increased threefold.

The Edison Medal winner this year was Dr. H. S. Osborne, consulting engineer, retired chief engineer, American Telephone & Telegraph Company. C. M. Mapes recounted the history of the medal, and H. I. Romnes sketched the career of the medalist. (For a full account of the Edison Medal proceedings, including the acceptance speech of the medalist, see pp. 252-56 in this issue of *Electrical Engineering*.)

The keynote speaker was D. G. Mitchell, president, General Telephone and Electronics Company, Inc., who spoke on "The Challenges to Engineering in the 1960's." His address can be found on pp. 243-47 in this issue of *Electrical Engineering*.

Technical Sessions Summarized

A brief account of various technical sessions follows:

Modern Circuit Techniques. An attempt to obtain quantitative answers to such large-signal high-frequency problems as the period, amplitude, output waveform (distortion), switching times and trigger requirements for oscillators and monostable and bistable switches was made by M. Schuller and W. W. Gaertner, Columbia Broadcasting System Laboratories. This attempt is based on the electrical behavior of the circuit which is characterized by a system of nonlinear differential equations in which certain functions, notably the nonlinearities, are given by tables of values measured on the actual devices used. The system of equations is then solved on a digital computer under given initial conditions, such as trigger pulses.

A companion paper by J. J. Tiemann, General Electric Research Laboratory, discussed a method for obtaining from tunnel diodes a negative conductance characteristic which has a very broad linear region. Other papers dealt with tunnel diode modulators, the dynamic behavior of negative resistance devices, and increasing the Q of a filter through the use of tunnel diodes.

Safety. A group of 5 papers thoroughly explored the field of electrical safety, attempting in particular to dispel widely held myths and general confusion surrounding the subject of grounding. C. F. Dalziel, University of California, discussed a varied assortment of current problems including safety grounding, grounding vs. bonding, relative hazard of 120 vs. 240 volts a-c systems, and double insulation for appliances and hand tools. D. M. Manson, CSA Testing Laboratories, Toronto, Ont., Canada, dealt with safe ungrounded portable electric appliances using the "extra insulation" principle. J. B. Hays concerned himself with the grounding of housings of cord-connected tools and appliances, and A. Stegenga, technical advisor to the Labor-Industry Inspection Department of the Netherlands, presented a paper on portable electric tools and electric equipment that was read by L. D. Price of the National Electrical Manufacturers Association.

Indicating Instruments and Calibration. C. F. Van Bennekom and R. M. Rowell, General Electric Company, presented "A Simplified Design of Long-Scale Ammeters and Voltmeters," which covered some of the basic concepts in the use of long-scale switchboard instruments. The paper described the development of a

new and simplified design of long-scale ammeters and voltmeters having unique characteristics that permit the use of printed predetermined scales.

A summary of the many outstanding advantages and features inherent in a taut band suspended mechanism, confirmed by 2½ years of actual field experience, was presented in a paper by a group of Westinghouse engineers. F. L. Hermach, National Bureau of Standards, made an analysis of errors in the calibration of electrical instruments, setting forth a logical procedure to determine what uncertainty or error the standards and the instruments being tested introduce in the measurements.

Telemetering. Telemetering in the pipeline industry, as an element of automation, enjoys a prominent position. As a result, a few key men located at key points can monitor and control a vast network of pipeline systems. But many problems remain to be solved. In a review of pipeline systems from early beginnings to the present, I. B. Cloessner, Jr., Humble Pipe Line Company, focuses attention on these problems. "Digital Telemetering Techniques," a paper by a group of engineers from Industrial Process Engineers, Inc., covered the basic principles of digital telemetering, its advantages and disadvantages when compared with analog telemetering techniques. Aspects of the technology of digital telemetering and some system design concepts were presented.

A companion paper was "Application of Digital Techniques in the Remote Control and Monitoring of Petroleum Production," by D. K. Butemeyer and A. C. Bradham, Texas Instruments Inc.

Space Communications. Commercial applications inherent in the space age were discussed in four papers. H. R. Mathwich of Radio Corporation of America dealt with "Synchronous vs. Low-Level Distributed Satellite Communication Systems." The author restricted his consideration to systems using active repeaters and those systems in which real time, 2-way traffic is to be carried out. Several synchronous satellites at an altitude of approximately 22,400 statute miles can provide virtually complete world-wide coverage. A low-level communication system requires a much larger number of satellites in several different lower altitude orbits. However, through careful choice of number and orbits, highly reliable transmission between pairs of ground stations may be obtained from the statistical probability of having at least one satellite in simultaneous view of ground station pairs. These two systems are competitive. Advantages and disadvantages of each system and some of the major problems involved are discussed. P. F. Glaser and E. R. Spangler, Space Technology Laboratories, dissected the Able-5 lunar satellite, largest and most sophisticated of the NASA-USAF Able series of space probes. Purpose of the Able-5 program is to place a scientific observatory in a relatively close lunar orbit to secure scientific data concerning the moon and its environment. Equipment that is carried allows for nine sets of experimental measurements to be made. These experiments, instrumentation, the engine used, and the temperature control system were discussed in some detail in the authors' presentation.

Ross Photo

PRIZE PAPER winners at the AIEE Winter Meeting were: (*left to right, seated*) Bern Dibner, Burndy Corporation, 1st prize, General Committee; J. E. Hogan, Pennsylvania Railroad, 1st prize, General Applications Division; Bernard Husock, Harco Corporation, 1st prize, Industry Division; (*standing*): S. C. Bartlett, American Electric Power Service Corporation, New York, 1st prize, Power Division; G. W. Dick, 1st prize, Science and Electronics Division, Bell Telephone Laboratories; and (*standing, at right*) R. A. Elco, Carnegie Institute of Technology, Pittsburgh, Pa., 1st prize, National Student Paper. L. F. Kennedy (*standing third from left*) was chairman of the Prize Awards Committee.

Two other papers were "Satellites Go Commercial—For Communications," by H. E. Weppler, American Telephone and Telegraph Corporation; and "Active Satellite Equipment for Communication Relays," by L. Pollack and D. R. Campbell, International Telephone and Telegraph Corporation Laboratories.

Man-Machine Aspects of Automatic Programming for Digital Control Systems. During the Fall of 1960, an experimental electronic telephone switching system (ESS) was placed in operation by the Bell System in Morris, Ill. This system is measuring various electronic system and equipment philosophies for commercial application in the telephone plant. One such philosophy is the concept of stored program control in which the detailed control of the call handling, maintenance, and administrative functions of the central office is centered in a stored program written to satisfy the requirements on the switching system. The paper by S. H. Washburn, Bell Telephone Laboratories, considers the process of producing stored programs for electronic telephone switching systems. Problems of telephone system programming are presented in a brief status report that examines the broad aspects of the problem in this early stage of the development of a commercial switching system.

D. T. Ross of the Massachusetts Institute of Technology discussed man-machine aspects of automatic programming for numerically controlled machine tools. Numerical control, as opposed to automation of particular tasks with great efficiency and precision, finds its greatest utility in general purpose machines which can perform a wide variety of tasks automatically, efficiently, and precisely, in accordance with numerical instructions which describe the jobs to be done.

A companion paper was the "Near Future Applicability of Problem Oriented Languages to Programming for Real Time Control Systems," by V. A. Vyssotsky, Bell Telephone Laboratories.

Lightning and Insulators. Results of switching surge tests plus wet and dry impulse and 60-cycle tests on a large variety of insulators and air gaps for ehv lines and stations (345 kv and above) are described in a paper by A. F. Rohlfs, H. E. Fiegel, and J. G. Anderson, all of whom work for General Electric Company. Data include vertical insulator strings, V-strings, pedestal insulators, horizontal and vertical gaps, insulator guy strings, and other important ehv insulation data. Unusual effects are noted which may profoundly influence insulation design.

R. W. Harmon, Ohio Brass Company, in his paper "Effect of Bundle-Conductor Field Influence on EHV Transmission Line Design," summarizes characteristics of some control shields used commercially at 345 and 460 kv and presents the results of laboratory tests which indicate the probable trend of the art for multiple-conductor systems above 460 kv. (This paper can be read in the March issue of *Electrical Engineering*, pp. 183-88.)

J. G. Anderson's paper, "Monte Carlo Computer Calculation of Transmission Line Lightning Performance," is concerned with a computer routine that will estimate probabilities of unwanted combinations of lightning stroke and line characteristics. Since this involves predictions from situations containing random processes, it can be compared to a gambling game with the significant exception that in the former case nature appears to have a marked deck of cards in her possession. This prevents her plays from being truly random, and creates non-Gaussian probability distributions in the game. Nevertheless, this routine, because it plays the game in advance according to statistical data obtained from field measurements, should enable more accurate estimates of line performance to be made.

Rotating Machinery. F. A. Scheda, Westinghouse, discussed the results of surge testing d-c armature windings, a rather complicated procedure. The purpose of the tests was to discover those areas in a d-c armature insulation system where the most severe stresses occur during surge testing. The author presented a technique for the rapid detection and identification of grounds, bar-to-bar shorts, shorts between coil layers and open circuits in both 2- and 4-pole d-c armature windings.

A companion paper discussed "High Frequency Iron Losses in Fractional Horsepower Induction Motors," losses that are common to all types of rotating machinery. V. C. Shaneman, the author, noted that the losses are caused by flux pulsations that result from the relative movement between the member being considered and an adjacent slotted member. High-frequency losses include what is commonly called rotor surface loss, rotor tooth pulsation loss, and stator tooth pulsation loss. Losses are manifested in form of a frictional drag on the rotor and subtract directly from the developed torque.

Telegraph Systems. Recent advances in printing telegraph apparatus and in the field of facsimile reproduction were covered in conference papers presented by W. Y. Lang, Bell Telephone Laboratories, and W. H. Bliss, Radio Corporation of America Laboratories, respectively. These papers were essentially reports from the various organizations connected with the design and production of equipment in these fields.

The definition and measurement of distortion are of fundamental importance for determining the reliability of telegraph transmission circuits, for judging quality of the component sections, and for planning teleprinter networks. In a paper by H. H. Wusteney, of Siemens & Halske A. G., Munich, Germany, work done in this field by the International Telegraph and Telephone Consultative Committee is described and evaluated.

Central Control Rooms for Power Stations. Features of centralized control rooms for stations of three electric utilities were described at a session sponsored by the Power Generation Committee. Two 175,000-kw units on the Potomac Electric Power Company's Dickerson station are now utilizing a single central control room, as reported in a paper by C. W. Schmitz, Jr., and C. S. Bilisoly. The concentration of controls and instruments at one location is the first step toward automatic data logging and, ultimately, computer-controlled operation.

A paper by E. Nilsson and G. A. Abbott describes present design practice of centralized control rooms in power plants of the Pacific Gas & Electric Company.

In a paper by J. L. Voyles and R. C. Austin, some of the control room features at the Detroit Edison Company's St. Clair power plant are covered. The last two of the plant's six units represent the company's latest thinking regarding control room function and design. Among the new features are control panels that combine the benchboard and vertical panel into a single panel, direct-connected instrumentation, separate control rooms for each unit, and more recording instruments to establish trends.

Land Transportation. K. H. Gordon, Pennsylvania Railroad, opened a Tuesday afternoon session with a paper concerned with contact wear on electrified railroads. He reported a survey made in 1958 covering 94% of the Pennsylvania's electrified road track miles. In conclusion, he stated that the cost and inconvenience of replacements can be held to a minimum if replacements are carefully planned and programmed over the years instead of permitting the wire to wear to the point where emergency measures become necessary.

A paper on the economic justification of U. S. railway electrification was given by H. C. Cross of Westinghouse Electric International Company. Results of a study show that a "technological package" with electrification will produce major and permanent savings greatly in excess of those produced by the package with dieselization. Moreover, the net capital investment is less and substantial increases are made in freight train speeds.

Electric control equipment for Disneyland monorail trains was described in a paper by J. J. Stamm, Westinghouse, and L. Adams, Walt Disney Productions. Power is obtained from a rectifier set and transmitted to the train by a novel current-collector system, with positive and negative shoes mounted on the train. An air-operated line breaker provides for positive closing and opening of the main motor circuit.

Switchgear. Mechanical effects produced in oil circuit breakers as the result of high-power fault interruption were discussed in a paper by M. G. Mathers and P. Wildi of the Federal Pacific Electric Company. The study described has demonstrated that vertical tank acceleration is the major factor to be considered in analyzing these mechanical effects.

E. B. Rutz, I-T-E Circuit Breaker Company, described the trend to single-tank oil breakers for subtransmission voltages. It is hoped that these breakers will be used in more and more higher-voltage applications, inasmuch as they offer advantages of simplicity in design, low cost, and reduced maintenance.

A paper by C. F. Wagner and A. R. Hileman, both of Westinghouse, presents proposed impulse tests based on calculation of lightning surge voltages which enter substations as the result of line flashovers. These proposed tests are also based on laboratory tests of rod and ring gaps.

Recloser control by means of electronics was covered in a paper by R. E. Riebs and N. J. Reis, Line Material Industries. The new recloser described should be suitable for substation applications formerly

PROMINENT at the Winter General Meeting were: *(left to right)* C. H. Linder, AIEE president; D. G. Mitchell, president of the General Telephone & Electronics Corporation, who was the principal speaker at the opening session of the meeting, and R. W. Gillette, general chairman of the meeting. Mr. Mitchell spoke on the topic, "The Challenge to Engineering in the 1960's."

Ross Photo

prohibited by lack of flexibility and difficulty in adjustment and testing. The high operating speed and proved interrupting structures of earlier reclosers have been retained.

System Planning and Economics. The first paper in a session sponsored by the System Engineering Committee was "Elimination Methods for Load-Flow Studies" by J. E. Van Ness of Northwestern University and J. H. Griffin of General Motors Corporation. The method described is much faster and will solve some problems that cannot be solved by the iteration method.

In a 2-part paper, F. M. Heck, Jr., Potomac Edison Company, describes a unified mathematical development of "cost-of-capital" from a few fundamental concepts. Cost-of-capital is defined as the rental (return), plus the tax paid to retain the rental (income tax) plus the cost of recovery of capital (depreciation). The correct treatment of depreciation is emphasized, inasmuch as many common errors and controversies arise out of misconceptions about this essential item.

F. W. Smith, Portland General Electric Company, reported on his experience in testing a small network analyzer which was experimentally modified to permit the operator to measure potential differences equal to the relative increment cost of delivered power at any bus on a load-flow study.

Rotating Machinery. A Thursday morning session featured various means of testing and making measurements on rotating machinery. B. V. Bhimani, General Electric, described a very-low-frequency high-potential testing procedure which utilizes a frequency of 0.1 cycle per second. This procedure provides the advantages of a-c testing while permitting great reductions in size and weight as compared to 60-cycle test equipment. In another paper, Mr. Bhimani discussed the measurement of resistance and capacitance on high-voltage insulation at very low frequencies.

In a paper by R. G. A. Brearley, D. A. Findlay, and C. C. Louttit, all of Aluminium Company of Canada, Ltd., the instator method for measuring power factor in generator windings is described and test results are evaluated.

Other papers presented were "Investigation of Maintenance Tests for Generator Insulation" by C. A. Duke, L. E. Smith, C. A. Roberts, all of Tennessee Valley Authority, and A. W. W. Cameron of Hydro-Electric Power Commission of Ontario; and "A Simulated Service Test for Evaluation of High-Voltage Turbine-Generator Insulation Systems" by E. A. Boulter, H. N. Galpern, and W. D. Bartlett, all of General Electric.

Wire Communications. O. A. Jorgensen, Stromberg-Carlson, opened a session on wire communications with a description of a system for automatic dialing and electronic selection on railroad message and dispatching circuits. Low-level tone signal techniques are used on multiparty single-line facilities. A total of 60 stations can be used on one pair of wires having a maximum attenuation of 30 db.

Telephone customers with properties at widely scattered locations frequently have communication needs that can, with present techniques, be served best with a network of leased telephone lines. R. A. Schaefer, Wisconsin Telephone Company, discussed the transmission aspects of such a private line telephone network, using as an illustration the communication system furnished to an electric power utility operating in central and southern Wisconsin.

The session closed with a paper by J. D. Howard, Southern Bell Telephone & Telegraph Company, on the administration of exchange area trunks for optimum transmission.

Magnetics. M. J. Schindler, Radio Corporation of America, opened a session on magnetics sponsored by the Basic Sciences Committee with a paper describing a method for designing high-coercivity permanent magnets that are to be exposed to magnetic fields from external sources. A considerable number of magnet assemblies have been designed on the basis of the analysis presented and fields were produced that were within ±5% of the predicted values.

In another paper, A. A. Borsei, University of California at Los Angeles, described a root-locus method for plotting hysteresis loops of ferromagnetic thin films. The method is based on the locus of roots of a polynomial, which is determined graphically by means of a "Spirule." Any combination of parameters may be investigated.

Other papers presented were "Transient Analysis of Interacting of Energy Transformation" by S. S. L. Chang, New York University, and "Synthesis of General Parameter Intersection Loss Filters Using a Digital Computer" by G. C. Temes, Northern Electric Company, Ltd.

AIEE Board of Directors Reports on Current Business and Long-Range Policy

"The Board of Directors shall manage the affairs of the Institute"—Constitution 70.011

AN executive of one of the country's largest corporations, speaking from an intimate knowledge of the Institute, said recently, "AIEE is a large and very complex organization, the management of which is a task calling for careful definition of objectives, sound organization, and accurate measurement of performance." Your Board of Directors has been applying itself to this task with energy and devotion. On Friday, January 27, 1961, just before the 1961 Winter General Meeting, the 11-man Executive Committee of the Board held an all-day session devoted to administrative matters to clear up the Board agenda for policy study. Then, on Friday, February 3, the last day of the Winter General Meeting, the 39-man Board put in a full day divided about equally between current business and long-range policy. The outline that follows reports in highly condensed form the essence of what the Board and the Executive Committee heard and did.

Finances. The Institute is obligated to spend its income in the service of its members, while maintaining a reserve to insure continuity of service and capital for improvement of facilities. The current situation is satisfactory in that, while income is down, expenses have been held in line. The result, at the end of the fiscal year, should be as budgeted; no loss, a little surplus. In the face of estimated expenses for moving into and furnishing new quarters next August, it is apparent that reserves will have to be tapped. Paper and printing prices continue to go up at an annual rate of 5% to 6% a year. Rent in the new quarters will be about double the present amount. The Finance Committee, under the chairmanship of C. T. Hatcher, has a difficult budget-making task for 1961-62. The sympathetic co-operation of all members is required.

Fellows. Twenty-three Fellows were elected. Their pictures and brief biographies will be found in subsequent issues. The Executive Committee directed that an effort be made throughout the Institute to recognize and promptly propose qualified candidates for the grade of Fellow. The Board, at its meeting, started a re-examination of the procedures by which Fellows are proposed and recommended to see if there are unnecessary difficulties that impede and delay the process.

Nominations, Elections, Appointments. The Planning and Co-ordination Committee was directed to look into the whole procedure of nominating officers and proposing and selecting committee personnel throughout the Institute with the purpose of devising a system or systems to develop a ready reserve of well qualified candidates for election and appointment to positions of responsibility at the various levels of the organization.

Local Honorary Secretaries, whose terms expire this year, were reappointed. A new Honorary Secretariat was established in France. M. F. M. Cahen (M '48, F '58), Controleur General Dion des Etudes et Recherches, 12 Place des Etats Unis, Paris 16, France, was appointed Local Honorary Secretary.

Appointment of C. T. Hatcher as chairman of the Finance Committee, to replace Dr. E. I. Green who resigned the chairmanship, was announced.

Prof. E. J. Smith was appointed to replace Prof. F. E. Canavaciol, both of Brooklyn Polytechnic Institute, as AIEE representative on the Alfred Noble Prize Committee.

Intersociety Relations. Fifty-four Sections and 22 Subsections reported meetings to discuss and vote on the several proposals for "Organizing the Engineering Profession to Achieve Unity."

The EJC (Engineers Joint Council) Annual Meeting was reported as indicating progress toward important goals in the co-ordination and management of technology.

Sir John Hacking, past president of IEE (Institution of Electrical Engineers) of Great Britain, and Dr. R. L. McFarlan, past president of IRE (Institute of Radio Engineers) were guests of the Board at luncheon. Each spoke of the work of his society.

ECPD (Engineers' Council for Professional Development) proposals for amendment of its charter and rules to establish two types of society membership, Technical and Sustaining, were approved by the Board, which also gave its approval to two societies proposed for Technical Society Membership.

Constitution and Bylaws. Constitution amendments, first proposed last June were confirmed with slight modification by the Board. These will be recommended to the membership for vote this Spring. The amendments change the wording of C20.010 and C20.070 and delete 20.071 and 20.072 to create a single student membership grade and to accept science as well as engineering students into membership. C20.031a and C20.041a are to be clarified without change in intent.

The "Code of Practice" of the Board of Examiners was modified to recognize graduates of science curricula in schools with ECPD-accredited electrical engineering curricula for 6-years experience credit toward the Associate Member grade.

The Bylaws were also amended. B80.022a, b will, as of August 1, 1961, provide that the District Representative of the Transfers Committee be a voting member of the District Executive Committee.

B40.011e was not amended, but it was interpreted as applying only to new members and not to any who might be seeking a convenient and inexpensive route to transfer.

B80.060d4 and B90.020a were amended with the following wording to become *effective immediately:*

B80.060d4 "It co-ordinates the scopes of all Technical Committees and co-ordinates joint activities with Technical Committees of other societies. It approves and schedules the locations and dates of the (a) authorized General Meetings, (b) District Meetings, and (c) Special Technical Conferences."

B90.020a "There shall be four General Meetings of the Institute each year; namely, the Winter General Meeting, the Summer General Meeting, the Pacific General Meeting, and the Fall General Meeting. Under delegated authority from the Board of Directors, the Technical Operations Department approves and schedules the locations and dates of the four authorized General Meetings, and may postpone or omit any such meetings. Additional General Meetings may be recommended to the Board of Directors from time to time by the Technical Operations Department."

Sections and Branches. Ever alert to the interests of its constituents, the GAD (General Administration Department) persuaded the Board to anticipate the Finance Committee and the Executive Committee in their budget-making functions; by approving the continuation of the Section bonuses for meetings and rebates on entrance and transfer fees for 1961-62. Likewise the 1961-62 appropriation for the continuation of the *EE Digest* was approved.

Medals and Awards. The PDR (Professional Development and Recognition) Department reported the approval of 10 major awards and medals of which 5 are presently established and sponsored. Three more are under consideration. The newly approved, but not implemented, awards are in Power Generation, Basis Sciences, Electric Power Utilization, Institute Service, and Electrical Engineering Literature.

Honorary Members. Two Honorary Members were elected. One presentation is scheduled for the 1961 Summer General Meeting at Cornell University in Ithaca, N. Y. The other will probably be presented at the 1962 Winter General Meeting.

Future Meetings. The 1962 Pacific General Meeting scheduled for San Francisco August 12-17 was cancelled, to be replaced by a Special Technical Conference.

In 1964, District 13 will meet at Birmingham, Ala., on April 1-3.

In 1964, District 5 will meet at Peoria, Ill., on April 22-24.

In 1965, the Summer General Meeting will be held at Miami, Fla., on June 20-25.

The next Executive Committee Meeting will be held April 28, 1961.

The Next Board meeting is scheduled for June 23, 1961.

Policy. Starting with the first meeting of the 1960-61 Board at Chicago last October, President Linder has conducted extended discussions of basic Institute Policy. After the Fall meeting, he published and distributed to all Institute officers two pamphlets outlining the major tasks and opportunities that lie before the Institute in its present environment. These are entitled "AIEE 1960-61" and "A Climate for AIEE." Future issues of *Electrical Engineering* will carry abstracts of these pamphlets and reports on the progress of the discussions and actions they are generating.

Some of the long-range questions which the Board is studying are the following:

(a) What are the long-range technical objectives of the Institute?
(b) What kind of meetings will best serve the members and our long-range technical objectives?
(c) What are the right criteria for accepting papers for publication?
(d) What kind of publications best serve the present needs?
(e) What nominating, electing, and appointing policies will insure future youthful, vigorous leadership?
(f) What adjustment in organization and procedure would speed the decision-making functions of AIEE?

25th Forum Is Held of Technical Committee Chairmen

The 25th Forum of Technical Committee Chairmen was held Wednesday, February 1, at the Statler-Hilton Hotel in New York City during the 1961 AIEE Winter General Meeting. F. L. Lawton, chairman of the Technical Operations Department (TOD), presided.

AIEE President C. H. Linder discussed the need for unity in the engineering profession. He stated that the traditional "barriers" separating the various types of engineering—such as mechanical, civil, chemical, and electrical—are becoming less and less realistic. Because there is so much overlapping in these fields, there is a tendency toward wasteful duplication in the various technical societies. He urged further co-operation between societies, and suggested that the Engineers Joint Council would be the logical group to act in a liaison capacity, fostering joint meetings, joint sponsorship, and closer co-operation. He also recommended more joint meetings at the local level.

L. G. Abraham, vice-chairman, Communication Division, discussed the problems involved in assigning technical session dates and in handling the papers quota. He described the methods used by the Communication Division to arrive at an effective solution which is equitable to the various Technical Committees in the Division.

The subject of TOD forecasts was discussed briefly by D. E. Trucksess, TOD first vice-chairman. These forecasts are used not only to assist AIEE Headquarters in planning space for meeting rooms, but also to serve as a means for budget control in the publication of technical papers.

Mr. Lawton then advanced a proposal for several changes in the AIEE papers policy. The chief change proposed would be that the present preprinted conference papers and Transactions papers would have the same status until after presentation at a meeting. Committee rulings on the status of papers would be released to Headquarters within 25 days after the meeting. There was much favorable response to the proposal, which will be given further consideration by the appropriate Institute groups.

Nominees To Hold AIEE Offices in 1961-62

Nominated To Serve as Institute President

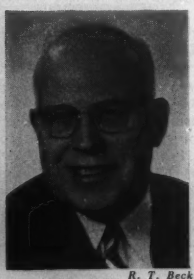
Warren H. Chase (M '42, F '51), vice-president, Ohio Bell Telephone Company, Cleveland, Ohio, has been nominated for the office of president of AIEE. Born January 25, 1898, in Cleveland, he received the S.B. degree in 1924 from the Harvard School of Engineering. Mr. Chase was employed as a toll transmission engineer for Ohio Bell during 1925-31, and assigned to circuit design and toll layout work. He was assigned to the supervision of transmission training schools, and the investigation and solution of special problems requiring transmission engineering training and experience. In 1940, he became a co-ordination engineer for Ohio Bell, in charge of measures to provide and protect telephone communications against interruption during a state of emergency. Mr. Chase was advanced to chief engineer in 1945 and placed in charge of the construction program for postwar telephone facilities, and the maintenance of transmission standards, toll line dialing projects, and the expansion of telephone facilities. In 1950, he became assistant vice-president, responsible for handling staff functions of inventory and cost, rate cases, rate and tariff matters, war activities and defense matters, overall company service results, and all directories for the Ohio Bell. He was appointed vice-president in 1954. Mr. Chase was the recipient of the 1960 "Engineer of the Week" Award for outstanding contributions to engineering and civic affairs in North Eastern Ohio. A registered professional engineer in the State of Ohio, he is a member of Eta Kappa Nu, the National Society of Professional Engineers, the Ohio Society of Professional Engneers, the Cleveland Society of Professional Engineers, the Cleveland Engineering Society, the Cleveland Technical Societies Council, the Atomic Waste and Radiation Committee of the City of Cleveland, and a senior member of the Institute of Radio Engineers. He is a member of the Communications Division of the National Defense Executive Reserve, and a past deputy director of the Communications Division of the National Production Authority. Mr. Chase has served as AIEE vice-president for District 11 (1958-59) and vice-president for District 14 (1959-61). He has been a member of the following AIEE Committees: Management (1954-58), Lamme Medal (1956-59), General Administration Department (1957-61), Planning and Co-ordination (1959-61), Board of Directors (1958-61), and Intersociety Relations (1959-61, chairman 1960-61). He was an AIEE representative to the Engineers' Council for Professional Development (1960-61).

Nominated To Serve as Institute Vice-Presidents

Thomas E. Marburger (AM '38, M '42, F '60), vice-president, Baltimore Gas and Electric Company, Baltimore, Md., has been nominated for the office of vice-president for AIEE District 2. He was born January 28, 1901, at Point Patience, Md., and received the B.S. degree in electrical engineering with honor in 1943 from Johns Hopkins University. Mr. Marburger entered the services of Consolidated Gas Electric Light and Power Company, now the Baltimore Gas and Electric Company, as a student engineer in 1922. He became superintendent, electrical construction, in 1933; general superintendent, engineering and construction, in 1957, and vice-president, in 1960. Mr. Marburger took a 7-months leave of absence to serve as director, Materials and Equipment Division, Defense Electric Power Administration, in 1951. He was a director in 1960 of Atomic Power Development Associates, Inc. He is a member of the American Society of Mechanical Engineers, the National Society of Professional Engineers, the Engineers Club of Baltimore, the Hopkins Engineers, the Newcomen Society of North America, and the Maryland Academy of Sciences. He is an associate member of the National Fire Protection Association and the American Meteorological Society. Mr. Marburger has served on the AIEE Management Committee (1960-61).

Ben V. Martin (M '49), headquarters representative for the Westinghouse Electric Corporation, Charlotte, N. C., has been nominated for the office of vice-president for AIEE District 4. Born October 21, 1905, in Clemson, S. C., he received the B.S. degree in electrical engineering from Clemson College in 1926. He began his engineering career as a graduate student in 1926 with Westinghouse. During 1927-32, he was employed in the Distribution Transformer Section of Westinghouse in Sharon, Pa. In 1932, he became manager of dry-type transformer and instrument transformer sales, a position he held until 1941. He wrote specifications for transformers for the Navy when they changed from direct to alternating current on shipboard. Mr. Martin was assigned to Westinghouse in East Pittsburgh, Pa., in 1941 as distribution apparatus manager. He was transferred to the Charlotte office in 1946 as sales engineer. Mr. Martin is a member of the North Carolina Society of Engineering and the Charlotte Engineers Club. He is a member of the National Electrical Manufacturers Association. He served as secretary of AIEE District 4 (1957-59) and has been a representative from District 4 to the AIEE Membership Committee (1959-61). He was a member of the AIEE General Industry Applications Committee (1956-58).

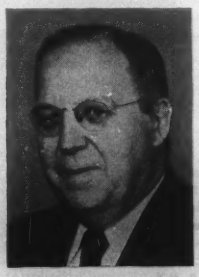
Warren B. Boast (AM '37, M '43, F '57), professor and head of the department of electrical engineering at Iowa State University, Ames, Iowa, has been nominated to the office of vice-president for AIEE District 6. Born December 13, 1909, at Topeka, Kans., he received the B.S. and M.S. degrees in electrical engineering from the University of Kansas in 1933 and 1934, respectively, and the Ph.D. degree from Iowa State College in 1936. Dr. Boast first joined the staff of Iowa State College in 1934 as a graduate assistant in charge of classroom and laboratory instruction. In 1936, he became an instructor, and in 1940 an assistant professor. He was employed as an assistant engineer for the City of Ames engineering department during the Summers of 1937 and 1941 on design, specifications, and reports. Particularly interested in the fields of electric circuits and illumination, Dr. Boast has served as a consulting engineer both to the Ames School Board and to the City of Ames on lighting problems. In the Summer of 1941, he also worked as assistant engineer for the City of Webster engineering department. He is the author of "Illumination Engineering," published in 1942 and 1953; "Principles of Electric and Magnetic Fields," published in 1948, and "Principles of Electric



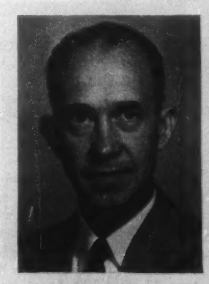
R. T. Beck

W. H. Chase

T. E. Marburger



B. V. Martin



W. B. Boast

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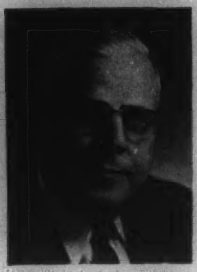
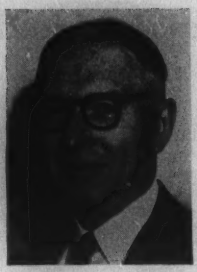
C. R. Day



Royal

J. P. Skillen



L. J. Weed

A. A. Johnson

and Magnetic Circuits," which appeared in 1950. Dr. Boast is a member of Sigma Xi, Tau Beta Pi, Phi Kappa Phi, Sigma Tau, Pi Mu Epsilon, Eta Kappa Nu, the Illuminating Engineering Society, and the American Society for Engineering Education. He has served on the AIEE Basic Sciences Committee (1953-61) and the Computing Devices Committee (1956-59).

Charles R. Day (AM '44, M '47), manager, engineering department, Sacramento Municipal Utility District, Sacramento, Calif., has been nominated for the office of vice-president for AIEE District 8. He was born September 19, 1907, in Gloster, Miss., and graduated from the University of California in 1932 with the degree of B.S. in electrical engineering. In 1932, he was employed in the electrical department of the Turlock Irrigation District, Turlock, Calif., assigned to meter testing and substation operation. He later worked in the meter test laboratory of the Department of Water and Power, City of Los Angeles, Calif., on the system frequency change program. Mr. Day did high-voltage cable testing for the General Cable Company, Emeryville, Calif. In 1937, he went to the electrical department of the Modesto Irrigation District, Modesto, Calif., where he worked on system operations and engineering. Mr. Day joined the Sacramento Municipal Utility District, Sacramento, Calif., in 1946 as one of a small group of electrical engineers active in the preparation for the beginning of the District as an operating electric utility on January 1, 1947. In 1960, he was promoted from supervising electrical engineer to manager, engineering department, where he co-ordinated civil and electrical design activities and system planning. He was a charter member of the Engineering Council of Sacramento Valley.

J. Prescott Skillen (AM '46, M '49), retired manager of power circuit breakers, Canadian Westinghouse Company, Ltd., Hamilton, Ont., Canada, has been nominated for the office of vice-president for AIEE District 10. He was born in St. Martins, New Brunswick, Canada, on July 3, 1899, and graduated from the University of New Brunswick in 1921 with the degree of B.Sc. in electrical engineering. In 1922, he joined Canadian Westinghouse on their Student Training Course. He was transferred to the company's test department in 1924. The following year, he was transferred to the switchgear engineering department, and in 1929 he became a switchgear engineer. In 1934, he was appointed laundry equipment engineer. He became Section engineer of the switchgear engineering department in 1937, and division engineer of the Switchgear Division in 1947. Mr. Skillen was named manager of product engineering in the Apparatus Division in 1951, and assistant manager in the engineering department of the Power Products Division in 1953. Four years later, he became assistant manager of the Switchgear Division, and in 1959, manager of power circuit breakers, a position he held until his retirement. He is a member of the Association of Professional Engineers of Ontario, and has served as chairman of the Switchgear Technical Committee of the Canadian Electrical Manufacturers Association. Since the Fall of 1960, he has been serving as a teacher of Drafting and Strength of Materials for the Hamilton Board of Education.

Leslie J. Weed (M '42, F '51), head of electrical engineering section, engineering and construction department, Boston Edison Company, Boston, Mass., has been nominated for the office of vice-president for AIEE District 12. He was born in Sandwich, N. H., on April 17, 1906, and studied electrical engineering at the Massachusetts Institute of Technology, from which he received the B.S. and M.S. degrees in 1923 and 1928, respectively. Mr. Weed made the preliminary engineering and economic studies which led to the adoption by Boston Edison of (a) the a-c secondary network system in downtown Boston, (b) the primary network system of distribution to replace certain radial distribution areas, and (c) the establishment of the common primary and secondary neutral system of distribution. He also made the original study which resulted in a lightning protection program for distribution transformers and installation of 4,160-volt capacitors on the distribution system. Upon adoption of the secondary network system, the primary network system, and the common primary and secondary neutral systems of distribution by the company, he was charged with the design and layout of the orginal system and was responsible for the growth and extension of these systems. As head of the Distribution Division of the engineering department, he was responsible for all engineering phases of distribution on the system from the stepdown substations to the customer's meter. During 1929-40, he taught engineering at Wentworth Institute, and in 1940-43, he was an instructor on the War Training Program. He taught at the Lincoln Institute in 1943-47, on the AIEE educational program in 1947-53, and at the Northeastern University Graduate School in 1954-58. Mr. Weed is a registered professional engineer, a member of Tau Beta Pi and of the Engineering Societies of New England. He has served on the AIEE Transmission and Distribution Committee (1951-61).

Alva A. Johnson (AM '32, M '44, F '50), manager, assembled switchgear and devices department, Westinghouse Electric Corporation, East Pittsburgh, Pa., has been nominated for the office of vice-president for AIEE District 14. Born July 25, 1909, in Mineral, Va., he received the B.S. degree in electrical engineering from the University of Virginia in 1930 and completed the Advanced Management Program at Harvard University in 1956. He was a student instructor at the University of Virginia during 1929-30. For the next 6 years, he was employed by the Consolidated Edison Company of New York as a junior engineer in the Test Bureau, and in 1936 became assistant engineer, Outside Plant Bureau. Mr. Johnson joined Westinghouse Electric in 1942 as central station engineer. In 1949, he became manager, electric utility engineering, and in 1953, manager of engineering, Switchgear Division. He became manager, assembled switchgear and devices department, in 1957. He is a registered professional engineer of the State of Pennsylvania. An AIEE director (1956-60), Mr. Johnson has served on the following AIEE Committees: Protective Devices (1947-54, chairman 1953-54), System Engineering (1947-50), Transformers (1947-54), liaison representative on standards (1951-54), Sections (1952-56), Power Division (1953-54), Switchgear (1954-57), Industry Division (1956-57), Publication (1956-57), Board of Directors (1956-60), Edison Medal (1957-59), Planning and Co-ordination (1957-61, chairman 1958-59), Special Publications (1957-58), and Nuclear Congress and Nucleonics (1958-59).

Membership in the American Institute of Electrical Engineers, including a subscription to this publication, is open to most electrical engineers. Complete information as to the membership grade, qualifications, and fees may be obtained from Mr. N. S. Hibshman, Secretary, 33 West 39th Street, New York 18, N.Y.

Nominated To Serve as Technical Vice-Presidents

Charles E. Dean (AM '23, M '37, F '55), consulting engineer, Hazeltine Research Corporation, Little Neck, L. I., N. Y., has been nominated as a technical vice-president of the AIEE to represent the Communications Division. He was born May 23, 1898, in Pickens County, S. C., and received the A.B. degree in 1921 from Harvard College, the A.M. degree in physics in 1923 from Columbia University, and the Ph.D. degree in physics in 1927 from Johns Hopkins University. During 1921-24, he was engaged at the engineering department of Western Electric Company. In 1927, Dr. Dean was employed by the American Telephone and Telegraph Company in New York. Since 1929, when Dr. Dean joined the Hazeltine staff, his work has included various patent studies and writing or editorial activity. During World War II, he was responsible for the large volume of instruction books on equipment made by Hazeltine and numerous subcontractors. In the early 1950's he took an active part in the formative period of the IRE (Institute of Radio Engineers) Professional Group on Broadcast and Television Receivers, and established their *Transactions* on a regular basis. During 1952-56, Dr. Dean had a large part in the writing and editing of the comprehensive engineering text, "Principles of Color Television." In 1958-59, he participated in the Television Allocations Study Organization and acted as chairman of a panel on picture quality from the subjective aspect. Dr. Dean is a Fellow of IRE. He has served on the following AIEE Committees: Publications (1942-44, 1954-58), Communication (1948-49), Broadcasting (1949-60, chairman 1952-54), Communication Division (1952-60, chairman 1960-61), Award of Prizes (1954-57), Standards (1956-59), Automation and Data Processing (1956-57), Special Publications (1957-60, chairman 1957-58), Periodicals and Transactions (1957-58), and Technical Operations (1959-61).

Lee R. Larson (AM '43, M '47), section chief, The Martin Company, Denver, Colo., has been renominated technical vice-president of the AIEE representing the General Applications Division. Mr. Larson received the B.S. degree in 1940 from the University of Denver and the M.S. degree in 1942 from Iowa State University, both in electrical engineering. He had a graduate teaching fellowship at Iowa State University during 1940-41, and was an instructor in the department of electrical engineering at the university during 1941-42. He was employed in the Naval Research Laboratory in 1943-56, successively, as a project engineer on aircraft electric equipment, section head, and branch head. During this period, the major effort was on airborne electric equipment with the scope ranging from evaluation of equipment to meet Naval requirements, to research programs on brushwear, equipment rating, and protective device requirements. Mr. Larson joined The Martin Company in 1956 as a staff engineer on guidance and control, and served as a technical consultant on electric, guidance, and electronic equipment. In 1958-60, he served as a principal engineer. Since 1960, he has been chief of the Standards and Components Section for The Martin Company. He is a member of the electrical advisory staff to the U. S. Air Force and Navy Departments, and holds membership in Eta Kappa Nu. Mr. Larson has served as AIEE technical vice-president from the General Applications Division (1960-61) and as a member of the following AIEE Committees: Aero-Space (1960), Transportation (1951-61, chairman 1955-57), General Applications Division (1955-61, chairman 1959-61), Award of Prizes (1955-57), and Technical Operations (1959-61).

J. H. Kinghorn (M '46), deputy chief, Electrical Engineering Division, American Electric Power Service Corporation, New York, N. Y., has been nominated for the office of technical vice-president of the AIEE to represent the Power Division. Born August 26, 1904, in Wheeling, W. Va., he was educated at the Carnegie Institute of Technology from which he received the B.S. degree in electrical engineering in 1926. After graduation, he was employed by the Wheeling Electric Company as a relay engineer, and in 1928 transferred to the parent organization, then the American Gas and Electric Company. He has served there successively as relay engineer, head of the relay and control section, assistant electrical engineer, and presently as deputy electrical engineer. Mr. Kinghorn has aided in the development and application of modern carrier current relaying, high-speed reclosing of circuit breakers, and modern concepts of backup relay protection. He is a member of the Electrical System and Equipment Committee of the Edison Electric Institute, the International Conference on Large Electric Systems, and of Eta Kappa Nu. Mr. Kinghorn is currently serving a 1-year term as technical vice-president, representing the Power Division (1960-61). He has served on the following AIEE Committees: Protective Devices (1947-49), Relays (1947-52), Power Generation (1953-61, chairman 1957-59), Prize Awards (1959-60), Power Division (1957-61, chairman 1960-61), Nuclear Congress and Nucleonics (1958-59), and Technical Operations Department (1960-61).

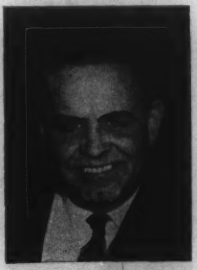
Nominated To Serve as Institute Directors-at-Large

John W. Davis (AM '33, M '55), assistant vice-president, Southern Bell Telephone and Telegraph Company, Atlanta, Ga., has been nominated to the office of AIEE director-at-large. Born December 12, 1898, in Owenton, Ky., he majored in physics at Georgetown College from which he received the B.S. degree cum laude in 1921. Upon graduation, he joined the engineering department of Southern Bell in Atlanta. In 1922, Mr. Davis was appointed exchange engineer in the Georgia Division, and from then until 1950 he held various positions in the engineering department, which included that of division plant engineer for Georgia, Mississippi, and Alabama. In 1950, he accepted the position of outside plant engineer on the company staff in Atlanta and served in this capacity until 1957, when he was appointed transmission and outside plant engineer on the East Area staff. In 1957, Mr. Davis was appointed assistant vice-president—staff operations, in which capacity he has staff responsibility for the co-ordination of the company's engineering program, including continuing engineering education. Clemson College conferred upon Mr. Davis the honorary degree of doctor of engineering at the June 1960 commencement exercises. Mr. Davis is a registered professional engineer. He has served as AIEE District 4 vice-president (1960-61) and on the Edison Medal Committee (1960-65).

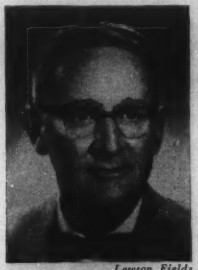
Lynn C. Holmes (AM '31, M '43, F '51), director of engineering operations, Electronics Division, General Dynamics Corporation, Rochester, N. Y., has been nominated to the office of AIEE director-at-large. He was born April 10, 1904, in

C. E. Dean

L. R. Larson



J. H. Kinghorn



Lawson Fields

J. W. Davis

Brookfield, N. Y., and was educated at Rensselaer Polytechnic Institute, where he received an E.E. degree in 1925 and an M.E.E. degree in 1932. During 1925-43, he was a member of the engineering faculty at Rensselaer, and served as counselor to the AIEE Student Branch for approximately 7 years. In 1943, Mr. Holmes joined the Stromberg-Carlson Company, which merged with General Dynamics Corporation in 1955, as senior engineer in charge of sound recording research. He was appointed associate director of research in 1950. Later the same year, he was named director of research and served in that capacity until 1959, when he was named to his present position. As a research engineer, Mr. Holmes made a number of significant contributions in the field of magnetic recording. In the Electronics Industry Association, Mr. Holmes has served as chairman of the Committee on Magnetic Recording and as chairman of the Committee on Phonograph Combinations. When the General Dynamics Scholarship Program was established in 1955, Mr. Holmes was appointed chairman of the Scholarship Committee at the Stromberg-Carlson Divison, and he continues in that capacity in the newly formed Electronics Division of General Dynamics. He is the representative from the division to the American Society for Engineering Education. Mr. Holmes is a member of Sigma Xi, Tau Beta Pi, the Research Engineering Society of America, the Acoustical Society of America, and a Fellow of the Institute of Radio Engineers. He is a registered professional engineer in New York State. Mr. Holmes has served as vice-president, District 1, and as a member of the following AIEE Committees: Communication (1947-49), Special Communication Applications (1949-52), Research (1958-60), and Recognition Awards (1959-63). He was a liaison representative on Standards (1953-54).

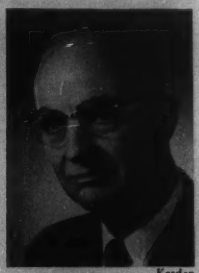
Nominated To Serve as Department Directors

Bradley Cozzens (AM '28, M '38, F '48), assistant chief electrical engineer, Los Angeles Department of Water and Power, Los Angeles, Calif., has been nominated for the office of AIEE director representing the General Administration Department. Born November 20, 1903, in San Jose, Calif., he received the A.B. degree from the College of the Pacific and 2 years later he graduated from Stanford University with an electrical engineering degree. In 1927, he began his Department career as a research engineer. His duties included insulation and transmission design for the Boulder Transmission Line. In 1939, he transferred to the Operating Division's Research and Records Section and the following year was appointed its head. In 1946, he became principal electrical engineer in charge of transmission and communications. During 1947-51, Mr. Cozzens served as executive assistant to the general manager, until he was promoted to the position of assistant chief electrical engineer. He is a member of the American Nuclear Society and the International Conference on Large Electric High Tension Systems. He is also a member of Sigma Psi, the Los Angeles Electric Club, and since 1940 has represented the Department on the Research and Statistics Committee of the Chamber of Commerce of which he is a member. Mr. Cozzens has served as AIEE vice-president (1955-57) and as a member of the following AIEE Committees: Sections (1949-55), Planning and Co-ordination (1954-55), Edison Medal (1955-57), Administration Department (1957-58), General Administration Department (vice-chairman 1959-60), Recognition Awards Committee (1960-64), and 75th Anniversary Committee.

Walter F. Denkhaus (AM '36, M '40), chief engineer, The Bell Telephone Company of Pennsylvania-Western Area, Philadelphia, Pa., has been renominated to the office of AIEE director representing the Publications Department. He was elevated to his present position of chief engineer in 1960. Mr. Denkhaus has been president of the Liberty Bell Chapter of the Telephone Pioneers of America, president of the Junior Section Engineers Club of Philadelphia, and treasurer of the Armed Forces Communications and Electronics Association. He is a member of the Engineering Societies Monograph Committee and the Atomic Energy Commission Advisory Committee on Industrial Information. Mr. Denkhaus has served as chairman of the Philadelphia Section, AIEE. He has served on the AIEE Publication Committee (1954-57, chairman 1959-61), the Planning and Co-ordination Department (1960-61), and as a member of the Technical Operations Department (1959-61). He is an AIEE director representing the Publications Department (1960-61).

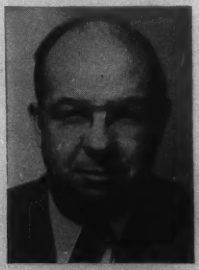
Nominated To Serve as Institute Treasurer

W. R. Clark (AM '37, M '44, F '61), manager, Product Engineering Division, Leeds and Northrup Company, Philadelphia, Pa., has been nominated for the office of treasurer of the AIEE. Born November 28, 1907, in Trainer, Pa., he was educated at the Moore School of the University of Pennsylvania from which he received the B.S., M.S., and Sc.D. degrees in 1929, 1932, and 1938, respectively, all in electrical engineering. He joined Leeds and Northrup in 1929 as a research assistant. In 1932, he became associated with the Franklin Institute Museum staff, where he took charge of the Electricity and Magnetism Section of the physics department. He returned to Leeds and Northrup in 1934 as an electrical research engineer. In 1945, Dr. Clark became supervisory research technologist of the Electrical Division of the research department, and in 1952 was appointed chief of this Division. He was appointed chief of the Electromechanical Division of the research and development department in 1955, and was appointed manager of the Product Engineering Division in 1956. He is a senior member of the Institute of Radio Engineers, a member of the Instrument Society of America, and the Engineers Club of Philadelphia, and has served on the Panel on Test Equipment of the Research and Development Board of the U. S. Military Establishment. Dr. Clark has served as AIEE treasurer (1960-61) and director (1959-60), and has been a member of the following AIEE Committees: Electronics (1945-55, 1958-61), Instruments and Measurements (1947-55, chairman 1949-51), Technical Program (1949-50), Standards (1949-50), Science and Electronics Division (1949-57, chairman 1952-54), Technical Operations (1952-61, chairman 1956-57), Instrumentation Division (1956-57), Recording and Controlling Instruments (1956-57), Board of Directors (1956-61), Planning and Co-ordination (1956-60), Constitution and Bylaws (1957-58), Recognition Awards (1957-58), Finance Committee (chairman 1958-60), and Executive Committee (1959-60). He is a District representative to the Technical Operations Department (1960-61).

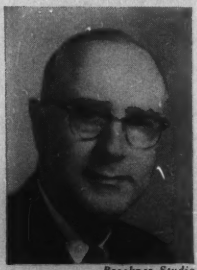


Varden

L. C. Holmes



Bradley Cozzens



Brookner Studio

W. F. Denkhaus

W. R. Clark

W. O. Swinyard Named NEC Chairman for Third Time

W. O. Swinyard, a founder and former president of Hazeltine Corporation, Little Neck, N. Y., has been named chairman of the National Electronics Conference (NEC) for the third time. The conference is co-sponsored by the AIEE.

He is the first to be so honored by the conference, which is an organization initiated in 1944 by a group of pioneers in electronics from education and industry for the purpose of advancing "the science of electronics and its application and use in the public interest and for the public good."

Mr. Swinyard is at present serving as a vice-president and director of Hazeltine Research, Inc., a subsidiary of Hazeltine Corporation. He is a Fellow of the Institute of Radio Engineers, of which he is also a former director and past chairman of its Chicago Section. He is also a Fellow of the American Association for the Advancement of Science and the Radio Club of America.

Representatives of Sections Meet To Discuss Problems of Common Interest

REPRESENTATIVES of AIEE Sections met on Tuesday, January 31, during the Winter General Meeting to hear presentations by various Institute officers and Committee chairmen, and to discuss problems common to the Sections.

The meeting was called to order by the presiding officer. W. E. Scholz, who is chairman of the Sections Committee. Mr. Scholz introduced G. B. Schleicher, secretary of the Sections Committee.

Welcome by AIEE President

Institute President C. H. Linder welcomed the Section Representatives.

In his remarks, he pointed out the effect of changing times on engineers and on the electrical industry, and the necessity of re-examining goals and progress.

He mentioned the three factors basic to the organization of the engineering societies: concern for ethical aspects of professional practice, concern for education, and need for communication on technical matters. At the moment, according to President Linder, the greatest opportunity and the greatest urgency exist in the area of technical exchange.

A tremendous number of technical meetings are being held, but of these, a tremendous number are duplicate meetings. Technical liaison is being accomplished strenuously but inefficiently. President Linder feels that on a national basis we must do a great deal with other societies to sponsor meetings jointly in order to remedy the situation.

The problem of communication is becoming increasingly complex. President Linder believes that if AIEE moves forward to work with other societies and takes a look at internal plans for meetings and publications, it can do much creatively in a few years.

Institute Finances

W. R. Clark, AIEE treasurer, discussed Institute finances and some of the problems of the Finance Committee.

The treasurer stated that the most important source of income is from dues and fees. Dues must be set at a proper level—neither too high nor too low. A difficult question, for which there is no rigid yardstick, concerns which activities should be maintained and how much money should be alloted to each.

Dr. Clark projected a series of slides which presented various financial data including a comparison of the first financial statement—from 1885—with the present financial position; sources of income in per cent; expenses in per cent. Of particular interest here to the Section Representatives was the fact that the General Administration Department was responsible for 17.2% of total expenditures, and the Sections spent 53% of this 17.2%.

Other slides showed net income and expenses, net income vs. member interests, and general fund cash balance.

In conclusion, the treasurer appealed to the Sections to work toward bringing in new AIEE members in order to help improve the financial situation of the Institute.

AIEE Member Gifts Campaign

H. H. Sheppard, vice-chairman of the Member Gifts Campaign Committee, whose function is to raise funds for the construction of the new United Engineering Center (UEC), summarized the situation.

According to the campaign report distributed at the meeting, pledges and contributions, as of January 1, have reached a total of $862,000 or 95.8% of AIEE's quota of $900,000.

These pledges and contributions were received from slightly more than 40% of the membership. A determined effort to contact all members is needed in order to raise the remaining $38,000.

Cleveland Section Chairman A. J. Hornfeck described the "new members" campaign which has proved very successful in his Section.

Following the discussion, A. L. Marshall, chairman of the Providence Section, presented to Mr. Scholz a $150 check as a UEC contribution from Section funds.

Section, Subsection and Territory Changes

Chairman Scholz announced Section, Subsection, and territory changes.

The new Calumet Subsection of the Chicago Section was formed effective August 1, 1960. The Counties of Jasper, Lake, and Newton, Ind.; the Townships of Bloom, Bremen, Rich, and Thornton, in Cook County, Ill.; and the Townships of Crete, Monee, Washington, and Will, in Will County, Ill., have been assigned to this new Subsection.

The new Fox Valley Subsection of the Chicago Section was formed effective November 1, 1960. The two Illinois Counties of DuPage and Kane have been assigned to this new Subsection.

The transfer of the nine Nebraska Counties of Antelope, Cedar, Dakota, Dixon, Holt, Knox, Pierce, Thurston, and Wayne from the Nebraska Section to the Iowa Section, all within District 6, was approved effective January 1, 1961.

The Hampton Roads Section, which was formerly a Subsection of the Virginia Section, will be granted full Section status effective March 1, 1961. The 18 Virginia Counties of Accomack, Essex, Gloucester, Isle of Wight, James City, King and Queen, Lancaster, Mathews, Middlesex, Nansemond, Norfolk, Northampton, Northumberland, Princess Anne, Richmond, Southampton, Surry, and York have been assigned to this new Section.

The North Alabama Section which was formerly the Huntsville Subsection of the East Tennessee Section, will be granted full Section status effective February 1, 1961. Associated with this petition was the request by the Muscle Shoals Subsection to transfer its area from the East Tennessee Section to this new North Alabama Section which was approved. The 11 Alabama Counties of Colbert, DeKalb, Franklin, Jackson, Lauderdale, Lawrence, Limestone, Madison, Marion, Marshall, and Morgan have been assigned to this new Section. DeKalb and Jackson Counties were transferred from the Alabama Section.

With these changes there are now 77 Subsections and 119 Sections in the Institute.

Membership Transfers

G. R. Wilhelm, chairman of the AIEE Transfers Committee, reminded the Representatives that transfer fee rebates help out Sections funds.

In his discussion he stressed the following points: number of transfers accomplished, continuity of effort in Section transfers committee work and organization of these committees, function of Section transfers committees, and proposed revision of the Transfers Guide.

As to the question of who should initiate transfers action—the individual or a Section committee—Mr. Wilhelm believes that committee procedure is best.

The discussion which followed was concerned mainly with the possibility of modifying Member Grade transfers forms.

Institute Technical Groups

P. K. McElroy, chairman of the Committee on Institute Technical Groups, discussed the factors which led to the decision by the AIEE Board of Directors to establish the Institute Technical Group (ITG) program, and the organization and function of such a program.

These points were covered in an article by W. R. Clark which appeared in the October 1960 issue of *Electrical Engineering*, pp. 793-800; and in a report in the January 1961 issue, pp. 70-71.

Mr. McElroy presented an analysis of the questionnaires which had thus far been returned on which members were asked to indicate interest in a particular ITG.

The questions which were asked indicated that there is some confusion as to how the ITG program would affect and fit in with present organizations of the individual Sections.

Section-Student Branch Co-operation

D. E. Garr, chairman of the Student Branches Committee, opened the afternoon session. He described a change in the method of informing a Section of graduating students who will be employed in that Section's area. The local Branch will now send names and addresses to Headquarters which will forward them to the Sections concerned.

Suggestions for organizing "After Graduation Panels" were given by Mr. Garr. Student reaction to the panels which have been sponsored has been very enthusiastic.

Public Relations in the Sections

C. F. Savage, chairman of the Institute Public Relations Committee, reviewed the objectives of public relations: (1) toward AIEE members—to point out the value of the Institute and to publicize its activities, and (2) toward the general public—to point out the value of engineering in general, and electrical engineering in particular.

Several manuals were mentioned which would be helpful to Section public relations committees.

Each Section public relations chairman will be asked to send a report to Headquarters on his activities. Mr. Savage believes that this will serve as an incentive to Section public relations work.

J. J. O'Connor, vice-chairman of the Public Relations Committee, told the Representatives about a tape which describes the radio program "Meet the Engineer." He suggested that a Section public relations chairman might interest his local station in the program with the aid of the tape.

Membership Activities

C. E. Monty, vice-chairman of the Membership Committee, reminded the audience that the most spontaneous growth in membership comes from the Sections. He urged the Sections to figure out ways to stimulate membership and suggested that Sections contact the District Membership Representatives if help is needed in this area.

The speaker believes that activity should be concentrated on following up delinquent members whose names are sent to the Sections.

In the discussion it was stated that not enough information is given to the Sections to enable them to identify the names satisfactorily. Several Representatives asked if Headquarters could supply additional information about Section members to the Sections.

Discussion

During an open discussion of Section problems which preceded adjournment, Mr. Scholz suggested that the Section delegate sent to the Summer General Meeting should be the incoming Section chairman.

Some of the Section problems discussed were the possibility of shortening membership applications, the value of sending mailings to student members, and the question of local student membership.

Cement Industry Conference To Be Held April 18-20 in Detroit, Mich.

THE 3rd AIEE Cement Industry Conference, sponsored by the Cement Industry Subcommittee of the AIEE General Industry Applications Committee and the Michigan Section, AIEE, will be held April 18-20 at the Sheraton-Cadillac Hotel in Detroit, Mich.

Detroit is the birthplace of automation and a center of mechanical and scientific skills, such as engineering, physics, designing, research, metallurgy, and chemistry. The cement industry is well represented in the Detroit area with several manufacturing and distribution plants.

Technical sessions will include the presentation of papers on maintenance and safety, automation, electric drives, and power distribution, as related to the cement industry. In addition to the technical sessions, arrangements have been made for a luncheon, banquet, and an inspection tour.

Reservations

Requests for room reservations should be mailed to the Sheraton-Cadillac Hotel, Detroit, Mich. If the facilities become overtaxed at this hotel, reservations will be made at nearby hotels. The price of the luncheon, banquet, and plant tour will be in addition to the registration fee. The cost of advance registration is $9, and for registration at the door, $11. Students and families of registrants will be admitted to the technical sessions at no charge. Additional tickets for the luncheon, banquet, and plant tour will be available at the Registration Desk.

Each registrant will receive one bound volume of all of the papers along with other conference information at the registration desk. Additional bound volumes will be on sale at the registration desk for $8 per volume, or can be obtained after the conference by mailing a request with remittance to: B. H. Schneider, Detroit Edison Company, 2000 2nd Ave., Detroit 26, Mich.

A new activity this year, the luncheon is intended to provide a convenient get-acquainted and eating facility for the first day of the conference, Tuesday, April 18. There will also be a luncheon speaker. The luncheon fee will be $4.

For the last 2 years, the most popular special event has been the banquet following the technical sessions. All registrants, wives, and guests are welcome at the banquet. It will be held in the Grand Ballroom of the Sheraton-Cadillac at 7:00 p.m. on Wednesday, April 19. Conference registration is not required for banquet attendance. The banquet fee is $8.

Inspection Trip

An inspection trip to the Enrico Fermi Atomic Power Plant at Monroe, Mich., and the new Dundee Cement Company Plant at Dundee, Mich., has been arranged for Thursday, April 20. The tour will be conducted from the Sheraton-Cadillac Hotel at 9:00 a.m. with two alternate termination arrangements. Arrangement No. 1 will terminate at the Sheraton-Cadillac Hotel at 4:30 p.m. Arrangement No. 2 will terminate at the Metropolitan and Willow Run Airports in time for planes departing from these terminals after 4:30 p.m. The tour fee will include chartered buses, and arrangements for luggage to airports. A luncheon will be provided by the representative cement companies in the Detroit area. The tour fee is $3.

Ladies will be welcome at any of the conference activities. Although there is no special ladies program, there are many events in Detroit from antiques to style shows to entertain the ladies.

An information center will be provided adjacent to the registration desk with up-to-minute news about current theatrical shows, movies, sport schedules, and the entertainment shows of Detroit's night spots. A bulletin board will be available for posting messages from the participants' offices or associates.

Any inquiries concerning this technical conference may be directed to the program chairman, L. E. Swanson, Peerless Cement Company, 1144 Free Press Building, Detroit 26, Mich.

Tentative Technical Program

The tentative technical program for the conference follows:

Monday, April 17

5:00 p.m. Registration

Tuesday, April 18

8:00 a.m. Registration

10:00 a.m. General Session

Presiding: J. F. Hower, chairman, Lehigh Portland Cement Co.

10:30 a.m. Maintenance and Safety

The Maintenance Function. *R. E. Stroppel*, Tool Steel Gear & Pinion Co.

What Do Accidents Cost? *J. R. D. Brown*, Portland Cement Assn.

Safety Considerations in Control Circuit Wiring. *H. P. Cassel*, Whitehall Cement Mfg. Co.

Progress Towards Recommended Practices To Improve Electrical Safety in Cement Plants. *E. E. Wilkens*, Nazareth Cement Co.

12:00 noon. Luncheon

1:30 p.m. Drives and Related Products

Moderator: W. G. Lefferts, Allis-Chalmers Mfg. Co.

Some Aspects of Static Power Supplies for Adjustable Speed Drives. *A. R. Olds, Jr.*, Kaiser Engineers: *R. B. Jones*, General Elec. Co.

Experiences with Adjustable Speed Kiln and Fan Drives. *R. P. Scott*, Penn-Dixie Cement Corp.; *T. Offrell*, F. L. Smidth & Co.

Low-Voltage Control Circuits in Cement Plants. *J. B. Woodward*, Bendy Engineering Co.

Drives for Dundee's Storage Hall Crane. *L. Kraszewski*, St. Lawrence Cement Co.: *W. C. Kant*, Milwaukee Crane Div., Novo Industries Corp.; *A. A. DiFrango*, Westinghouse Elec. Corp.

Report on Suggested Recommendations for Electrical Drives in the Cement Industry. *R. J. Jager*, Lone Star Cement Corp.

4:30 p.m. Adjourn

Wednesday, April 19

8:00 a.m. Registration

9:00 a.m. Distribution

Moderator: E. E. Wilkens, Nazareth Cement Co.

Progress toward Recommended Practices for Cement Plant Power Distribution. *A. C. Lordi*, Westinghouse Elec. Corp.

What Is Interrupting Capacity and Why Is It Important to Cement Plants? *L. E. Swanson*, Peerless Cement Div., American Cement Corp.; *S. E. McDowell*, Allis-Chalmers Mfg. Co.

What Should Be Included in Specification Writing for Electrical Contractors for Cement Plant Use? *R. C. White*, Macdonald Engineering Co.; *G. R. Bach*, Diefenderfer, Inc.

Considerations of the Power Distribution System for Starting Motors in Cement Plants. *T. M. Ho*, Kaiser Engineers; *Harold Robinson*, Westinghouse Elec. Corp.

Interesting Features of the Electrical Equipment at Dundee Cement Company. *J. A. Allan*, St. Lawrence Cement Co.

12:00 noon Lunch

1:30 p.m. Automation

Moderator: A. H. Huelsman, General Elec. Co.

Some Basic Concepts Involved in Automating Cement Plants. *E. A. E. Rich*, General Elec. Co.

The 1961 Status of Riverside Cement Computer. *L. W. Weeks, D. A. Johnson*, Riverside Cement Div., American Cement Corp.

Our Experiences with Instrumented and Centralized Controls in Cement Plants. *W. Walkling*, Ideal Cement Co.

Recommended Practices for Automatic Operation of Processes in Cement Plants. *H. P. Cassel*, Whitehall Cement Mfg. Co.

New Developments in Automation in Cement Plants including Recent Developments in X-Ray Chemical Controls. *A. H. Huelsman*, General Elec. Co.

4:30 p.m. Adjourn

7:00 p.m. Banquet

Toastmaster: R. E. Stroppel

Address: C. B. Baker, president, Universal Atlas Cement Div., U. S. Steel Corp.

Thursday, April 20

9:00 a.m. Inspection Tour

Enrico Fermi Atomic Power Plant and the Dundee Cement Company.

Tom Root Air Photo

COMPLETE facilities of the Dundee Cement Company at Dundee, Mich., are shown in this aerial photo. The plant will be the subject of an inspection tour at the Cement Industry Conference. These facilities are among the most modern in the industry.

AN aerial view is shown of the Enrico Fermi Atomic Power Plant at Monroe, Mich., the world's largest breeder reactor atomic power plant. The design of this plant was made by the Atomic Power Development Associates, Inc., with the nuclear portion assigned to the Power Reactor Development Company. The conventional turbine generator portion is being handled by the Detroit Edison Company.

Conference Committee Named

The conference committee, representing the Cement Industry Subcommittee and the Michigan Section, AIEE, includes the following:

Cement Industry Subcommittee. Executive Committee—J. F. Hower, general chairman; R. J. Jager, vice-chairman; R. E. Stroppel, advisory chairman; E. A. E. Rich, secretary; W. G. Lefferts, drives; A. C. Lordi, distribution; H. P. Cassel, maintenance and safety; A. H. Huelsman, automation; D. B. Carson, West Coast working group; W. A. Allan, past general chairman; L. E. Swanson, 1961 program chairman; J. B. Woodward, 1962 program chairman; and G. E. Macdonald, 1963 program chairman. General Committee—J. A. Allan, J. R. D. Brown, C. E. Burleson, P. E. Carlson, W. J. Cherones, G. H. Ember, F. B. Hunt, E. R. Kirkham, D. A. Johnson, F. W. Matthaei, J. A. Mitchell, V. G. Murdock, T. Offrell, A. R. Olds, F. J. Renn, W. A. Reynolds, C. E. Roberts, R. P. Scott, W. Walkling, R. C. White, E. E. Wilken, and Executive Committee.

Michigan Section, AIEE. J. J. Fredrickson, chairman; A. C. Fagerlund, vice-chairman; H. S. Mika, secretary-treasurer; and H. R. Armstrong, national Conference co-ordinator. 1961 Technical Meeting Committee—L. E. Swanson, chairman; E. H. Hammerstein, vice-chairman; D. B. Hill, secretary; B. H. Schneider, treasurer; M. W. Heidman, facilities; R. K. Gunsaulus, hospitality; A. J. Mestier, registration; H. J. McGill, publicity; W. R. Dersnah, plant tours; W. A. Reynolds, publications; J. A. Mitchell, promotions; J. A. Allan, meeting scheduling; R. E. Stroppel, advisory chairman; J. B. Woodward, advisory; G. E. Macdonald, advisory; V. G. Murdock, advisory; and R. S. Gardner, AIEE Headquarters.

Globecom V To Feature 90 Papers on All Phases of Communications Engineering

SPONSORED by AIEE and the Professional Group on Communications Systems of the Institute of Radio Engineers, the 5th National Symposium on Global Communications (Globecom V) will be held at the Hotel Sherman, Chicago, Ill., on May 22-24.

The 3-day program will feature some 90 papers covering all phases of the communications engineering field. These will be presented in three simultaneous sessions during each morning and afternoon of the conference. Exhibits by more than two dozen manufacturers and engineering organizations in the communications industry will be displayed all 3 days. A social hour will complete the activities on Monday, May 22, and a luncheon meeting will be held on Tuesday, May 23.

The program and advance registration forms will be sent to the symposium mailing list by April 1. Names will be added to the list upon request to: C. F. Wittkop, Motorola, Inc., 1450 N. Cicero Ave., Chicago 51, Ill.

The tentative program of papers to be presented is as follows:

Monday, May 22

9:30 a.m. Sessions

Space Communication I

Passive Communication Satellites with Diffuse Scattering Characteristics. *H. P. Raabe*, General Mills, Inc.

Advanced Communications Technology and Future Aircom System Design. *L. A. De Rosa, E. W. Keller*, ITT Communication Systems, Inc.

ULTRACOM, Ultraviolet Communciations System. *J. W. Ogland*, Westinghouse Elec. Corp.

Exotic Methods in Space Communications. *L. Bittman*, Martin Co.

Space Communications with Gamma Radiation. *J. W. Eerkens*, Nuclear Associates

Data Transmission

Global Digital Communications. *C. A. Deutschle*, ITT Communications Systems, Inc.

Reliable Data Transmission on Common Carrier Facilities. *J. L. Wheeler*, Stromberg-Carlson Co.

Coded Feedback for Error Correction in Binary Data Transmission. *J. R. Weyer*, Armour Research Foundation.

Magnetic Tape to Printer Communications System. *T. P. Donaher*, Stromberg-Carlson Co.

SYSEC: System Synthesizer and Evaluation Center. *T. R. Sheridan*, RCA Labs.

Communications Systems

Radio Wave Propagation through the Earth's Deep Rock Strata—A New Medium of Communication. *G. J. Harmon*, Raytheon Co.

Global Communications for Project Mercury Using Facilities of Common Carriers. *R. E. Mollbert*, Western Elec. Co.

Discussion of Slow Scan TV System. *N. Hoag* ITT Labs.

Microwave Wire (G-Line) as a Broadband Information Highway Using Established Pole Routes. *T. Hafner*, Surface Conduction, Inc.

Electronic Transmission of Mail. *L. Feit*, ITT Labs.

2:00 p.m. Sessions

A Large-Scale Four-Wire Switched Communications Network for Military Communications

Philosophy and General Features of the System. *J. W. Gorgas*, Bell Telephone Labs.

The Transmission Plan. *H. H. Felder, D. T. Osgood*, Bell Telephone Labs.

Switching Features. *J. W. Brubaker*, Bell Telephone Labs.

Employment of the Signal Corps Automatic Network. *Lt. Col. McNeil*, U. S. Army Communications Agency

Systems Engineering Aspects of the Signal Corps Automatic Network. *L. L. Gaddis*, A. T. & T.

System Performance

Noise and Transmission Level Terms in American and International Practice. *H. H. Smith*, ITT Communications Systems, Inc.

Nomograms for the Statistical Summation of Noise in Multihop Communication Systems. *B. Sheffield*, ITT Communication Systems, Inc.

Multiplex Stability and Interface Requirements for Aircom Circuits. *G. Golsos, P. H. Bourne*, ITT Communications Systems, Inc.

Synthesis of a Global Communications System Using Wideband Radio Relay Systems. *J. B. Potts*, RCA

Performance Rating of Communications Systems. *J. C. G. Carter*, Westinghouse Elec. Corp.

H F Communications

Optimum HF Prediction. *H. Greenberg, S. Krevsky, G. Bumiller*, RCA

The AVCO Natural Communication System. *S. C. Coroniti, G. E. Hill, N. J. Macdonald, R. Penndorf*, AVCO Corp.

Frequency Sounding Techniques for HF Communications over Auroral Zone Paths. *G. W. Jull, G. W. Irvine, J. P. Murray*, Defense Research Telecommunications Establishment

Modern Ionospheric Measuring Equipment. *D. H. Covill*, E.M.I.—Cossor Electronics Ltd.

Radiotelephone Communications on the Great Lakes and the Seaway. *H. H. Herrick*, Lorain County Radio Corp.

Tuesday, May 23

9:30 a.m. Sessions

Space Communication II

Unfurlable Antennas for Space Communication. *P. D. Kennedy*, Lockheed Aircraft Corp.

A Broadband HF Antenna Sytem for Use in a Satellite Ionospheric Sounder. *J. R. Richardson, A. R. Molozzi*, Defence Research Telecommunications Establishment

Communications Satellites Using Active Van Atta Arrays. *R. C. Hansen*, Aerospace Corp.

Phase-Locked Loops for Electronically Scanned Antenna Arrays. *R. C. Colbert, W. L. Rubin*, Sperry Gyroscope Co.

Advanced Scanning Feed for the AT-36 60-Foot-Diameter Automatic Tracking Antenna. *E. Villaseca*, Dynatronics, Inc.; *R. E. Moseley*, Scientific Atlanta, Inc.

Modulation Techniques

An Experimental Delta Modulator. *M. Kozuch, A. Lender*, ITT Labs.

The Use of Log Differential PCM for Speech Transmission in UNICOM. *R. L. Miller*, Bell Telephone Labs.

A High Speed, Serial, Four-Phase Data Modem for Regular Telephone Circuits. *G. L. Evans, E. Enriquez, Q. C. Wilson*, Hughes Communications Division

A New Digital Communication System-Modified Diphase. *G. Aaronson, D. A. Douglas, G. J. Meslener*, RCA

Wideband Frequency Modulator. *L. D. Westenburg, H. D. Hern*, Collins Radio Co.

Pacific Scatter Communication System

Pacific Scatter Communication System. *J. Rose*, Defense Communications Agency; *A. A. Childers*, U. S. Army, Office of the Chief Signal Officer; *H. H. Jones, Jr.*, U. S. Army Signal Engineering Agency; *R. Bateman, D. F. Brittle, Jr.*, Page Communication Engineers, Inc.

Improved Ionoscatter Receiving Techniques Used on the Pacific Scatter Communication System. *J. Rose*, Defense Communications Agency; *A. A. Childers*, U. S. Army, Office of the Chief Signal Officer; *H. H Jones, Jr*, U. S. Army Signal Engineering Agency; *G. E. Boggs*, Page Communication Engineers, Inc.

Performance Monitoring of the Pacific Scatter Communications System. *J. Rose*, Defense Communications Agency; *A. A. Childers*, U. S. Army, Office of the Chief Signal Officer; *H. H. Jones, Jr.*, U. S. Army Signal Engineering Agency; *J. S. McLeod*, Page Communication Engineers, Inc.

The Piggy-Back Dual Corner Reflector Antenna. *J. Rose*, Defense Communications Agency; *A. A. Childers*, U. S. Army, Office of the Chief Signal Officer; *H. H. Jones, Jr.*, U. S. Army Signal Engineering Agency; *J. S. Stotsky, J. McMahon*, Page Communication Engineers, Inc.

2:00 p.m. Sessions

Switching Systems I

Network Compatibility in Global Telephone Switching Systems. *C. A. Parry, P. O. Dahlman*, Page Communications Engineers, Inc.

Parametron Applications in Military Switchboards. *S. Kaplan, L. Stambler*, RCA

Alternate Routing Computer. *A. Kritz, H. Roberts*, RCA

Message Storage in Automatic Switching. *W. F. Spanke*, U. S. Army Communications Systems Division.

Traffic Management Techniques. *A. G. Steinmayer, O. O. Jones, H. B. Collins, Jr*, General Elec. Co.

Microwave Radio Relay

A Modern Approach to Microwave Communications Systems. *G. I. Carlson*, Motorola, Inc.

A Transistorized Multichannel SSB Carrier Telephone System. *F. Correia*, Motorola, Inc.

Transistor Alarm and Control System for Unattended Microwave Repeater Stations. *L. Moore*, Moore Associates, Inc.

Possibility of Noise Figure Reduction of a Microwave Receiver Using a Reflex Klystron Amplifier. *K. Ishii*, Marquette Univ.

Design of a TD-2 Microwave Repeater with Transmitters and Receivers on the Same Frequency. *P. B. Engh*, Pacific Telephone & Telegraph Co.

Reliability and Survivability

The Planning of Space Communication System Reliability. *E. D. Karmiol, A. Sternberg, J. S. Youthcheff*, General Elec. Co.

Communication Error Rate Instrumentation System. *V. Chewey, J. Wittman, J. Rabinowitz, A. Tepfer*, RCA

A Technique for the Physical Survivability Analysis of a Communications Network. *D. F. Pascucci, N. P. Albrecht*, ITT Labs.

Circuits, Networks, and Survival. *J. W. Halina*, ITT Communication Systems

Availability—New Approach to the Measurement of System Reliability. *M. Barow, S. R. Calabro, V. Selman*, International Elec. Corp.

Wednesday, May 24

9:30 a.m. Sessions

Space Communication III

A Global Party Line Concept of Satellite Communication. *J. L. Walker*, ITT Communications, Inc.; *D. R. Campbell, W. L. Glomb*, ITT Labs.

Optimization of System Parameters for Deep Space Communication Systems. *M. E. Breese, P. J. Sferrazza*, Sperry Gyroscope Co.

The Delay/Coverage Problem in Telecommunications via Satellites. *A. J. Vadasz*, General Elec. Co.

Theoretical Considerations in Design of Delayed Time Satellite Repeater Systems. *J. Dressner*, U. S. Army Signal Research and Development Lab.

Some Studies of Special Orbital Configurations for Global Communications. *S. C. Hight, J. G. Kreer*, Bell Telephone Labs.

Data Handling

Micro Programmed Digital Data Handling System. *J. C. Augustine*, Space Technology Labs., Inc.

A Binary Information Exchange. *R. C. P. Hinton*, ITT Communications Systems, Inc.; *C. E. Haller*, ITT Labs.

Automatic Keyboard-Operated Morse Code System without Tape. *R. W. Johnson*, R. W. Johnson Co.

DIGIKEY—A Keyboard Technique for Digitalizing Human Information. *S. G. Lutz*, Hughes Research Labs.

A Technique for Converting Analog Voltages to Digital Codes at Sampling Rates above Five Million Samples per Second with Accuracies of Seven Bits. *O. F. Crocker*, Raytheon Co.

Forward Scatter

Latest and Future Trends in Tropospheric Scatter Communications. *C. P. Durnovo*, Adler Electronics, Inc.

Basic Considerations of Economy-Type Troposcatter Systems. *L. P. Yeh*, Page Communication Engineers, Inc.

Propagation Phenomena and Diversity Combiner Problems Encountered on a 690-Mile Multichannel Troposcatter System. *W. H. Gentry*, Jr., General Elec. Co.

Radio Propagation at UHF by Incoherent Scattering in the F-Region. *H. W. Briscoe, V. C. Pineo*, MIT Lincoln Lab.

Mutual Interference between Point-to-Point and Space Communications Systems. *W. J. Hartman, M. T. Decker*, National Bureau of Standards

2:00 p.m. Sessions

Switching Systems II

The Problem of the Tributary Area in Planning a Military Switched Global Network. *P. M. King, G. C. Hartley*, ITT Communication Systems, Inc.

Terminal Area Distribution and Processing. *H. H. Pine*, ITT Communication Systems, Inc.

A Fully Electronic TDM Solid-State Switching Center for Military Communications—Grouping, Signaling, Logic. *A. K. Bergmann*, North Elec. Co.

A Fully Electronic TDM Solid-State Switching Center for Military Communications—Transmission Characteristics and Their Measurements. *G. Svala*, North Elec. Co.

An Automatic Electronic System for Handling International Telegrams. *E. D. Becken, R. K. Andres*, RCA Communications, Inc.

System Planning

Application for Transmission Media. *J. H. Vogelman*, Capehart Corp.

The Economies of Communications Satellites. *W. Meekling, S. Reiger*, Rand Corp.

Optimization Methods in Economics Planning of Telecommunications Systems. *Z. Prihar*, Page Communications Engineers, Inc.

Value Engineering Applied to a Large-Scale Electronic Communications System. *B. Ellison*, International Elec. Corp.

Communications Cost Control Analysis—Integration of Communication and Data-Processing Systems. *J. K. Mulligran, T. R. McKee, J. P. Macri*, RCA

Speech Compression and Spectrum Sharing

The Speech Bandwidth Compression Problem. *F. H. Slaymaker, R. A. Houde*, Stromberg-Carlson Co.

A 1,000-Bit-per-Second Speech Compression System. *J. S. Campanella, D. C. Coulter, R. Irons*, Melpar, Inc.

Band Economy Multiplex Equipment Applied to Long Distance Trunk Groups. *G. Atkinson*, ITT Communications Systems, Inc.

Unscheduled Spectrum Sharing in Communication. *D. P. Harris*, Lockheed Aircraft Corp.

Designing Interference—Free Space Communication Systems Using Computer Simulation Techniques. *D. R. J. White*, Frederick Research Corp.

Technical Conference Sponsored by AIEE Committee

A special technical conference, sponsored by the Aero-Space Transportation Committee, AIEE, will be held at the Benjamin Franklin Hotel in Philadelphia, Pa., on June 26-30. Scientists and engineers of the Aero-Space Electrical Industry are invited to attend. The conference is open to members and nonmembers of AIEE and their wives.

Reservations may be arranged through J. A. Scarcelli, 3198 Chestnut St., Philadelphia, Pa.

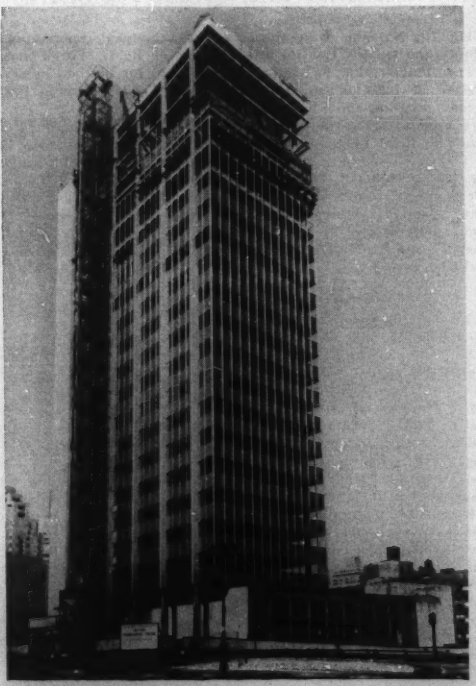
A series of outstanding technical papers will be presented and discussed. Some of the areas that will be developed through technical presentations include: unconventional power generation, static devices (exciters, voltage regulators, inverters, converters, and relays), brushless generators, support power equipment, system checkout equipment, variable speed constant frequency systems, hydraulic/mechanical constant speed drive systems, high-temperature environment, reliability, design philosophy, radiation problems with electric components, distribution system interconnection, and aircraft and missile structure testing as applied to Aero-Space Transportation.

Modern electric equipment will be displayed featuring the latest equipment and techniques available in the field of Aero-Space Electricity. Some of the exhibitors include General Electric Company, Bendix Company, Jack & Heintz, and Westinghouse.

The 1961 conference is the first East Coast conference since 1950, when it was held at Baltimore, Md.

Construction of UEC Progresses

THIS photo of the United Engineering Center (UEC), situated on the United Nations Plaza between 47th and 48th Streets in New York City, was taken February 1. The $12 million structure will house 18 American engineering groups when construction is completed. The scheduled time for completion is mid-1961. Twenty stories high, the building will contain 18 stories of office space and 2 of mechanical equipment. Its appearance will be that of a slim tower of glass, stainless steel, and limestone which arises from a broad 2-story base of glass and stone. The office space will provide meeting rooms for 400 persons, plus smaller conference rooms. An exhibit area of 6,235 square feet and a cafeteria to seat 350 are also contained in the structure.



Wagner International

AWARD winners of the 7th National Symposium on Reliability and Quality Control were congratulated by Gen. L. I. Davis, commander, Air Force Missile Test Center, and W. T. Sumerlin of Philco. Pictured are: *(left to right)* R. G. Fitzgibbons of Raytheon, General Davis, Dr. L. W. Ball of Boeing, Mr. Sumerlin, M. T. Votaw and R. L. Easton of the Naval Research Laboratory, and R. E. Moe of the General Electric Company.

1,253 Attend 7th Symposium on Reliability and Quality Control

THE 7th National Symposium on Reliability and Quality Control held January 9-11 in Philadelphia, Pa., had a total registration of 1,253, which was a 12% increase over the one held last year in Washington, D.C. There were 23 in attendance from 7 foreign countries.

The highlights were the keynote speech by H. L. Hoffman, president, Hoffman Electronics Corporation, Los Angeles, Calif.; a talk by Major General L. I. Davis, commander of the Air Force Missile Test Center, Cape Canaveral, Fla.; and several technical sessions.

Awards Presented

Two of the nation's leading scientists, R. L. Easton and M. J. Votaw, of the U.S. Naval Research Laboratory, Washington, D.C., were presented jointly with the 1960 IRE (Institute of Radio Engineers) Professional Group on Reliability and Quality Control award in recognition for their contributions to the electronic engineering profession by their work on the design and development of the radio transmitter in the Vanguard I satellite.

R. E. Moe, General Electric Company, was given the 1960 National Reliability Award for the best paper presented at the 6th National Symposium in 1960. The 1960-61 ASQC (American Society for Quality Control) Electronics Division Award was given to Dr. L. W. Ball, Boeing Airplane Company, for his technical contributions in the field of reliability and quality control. The 1960 National Symposium Award was given to R. G. Fitzgibbons, Raytheon Company, for the best moderated session at the 6th Symposium in 1960.

Call for Papers Issued

An invitation for abstracts of papers for the 8th Symposium to be held in Washington, January 9-11, 1962, has been issued. These abstracts should be sent to M. P. Smith, Minneapolis Honeywell Regulator Company, Aeronautical Division, 13350 U.S. Highway #19, St. Petersburg, Fla., by May 1, 1961.

Appliance Conference Set for May 1-3 in Louisville

Leakage currents, double insulation, and component reliability will be among the key topics at the 12th annual Appliance Technical Conference, to be held May 1-3 at the Kentucky Hotel, Louisville, Ky. Sponsored by the Domestic Appliance Committee, AIEE, the technical meeting will be open to nonmembers as well as AIEE members. A special feature of the program will be a tour of General Electric's Appliance Park in Louisville.

Some of the papers scheduled for presentation are: Thermostatic Bimetals, Cable Heaters, Leakage Currents in Appliance Heaters, Double Insulation, Decomposition of Chlorine Bleach in Washing, Improving Moisture and Water Resistance of RAC Fan Stators, Over Surface Failure of Hermetic Compressor Motor Feed through Terminals, and Component Reliability. Other papers to be presented are still in the process of clearance.

More than 300 appliance engineers attended the 11th annual Appliance Technical Conference at Mansfield, Ohio, in 1960. Advance interest in this year's program indicates that record will be broken. Registration for the conference may be made by writing: W. F. Kindt, c/o General Electric Co., AP-2 Room 241, Louisville 1, Ky.

First Status Report Given by ITG Committee Chairman

P. K. McElroy, chairman of the Institute Technical Groups (ITG) Co-ordinating Committee, has issued a First Status Report on ITG's.

Indicating a healthy early interest in the ITG, 968 returns have been received through February 6, the vast majority via the return cards.

Of these, 511 listed only one Technical Committee as an area of interest. The remaining 457 listed on the average almost four areas of interest. In many instances, there were repeated combinations; for example, Transmission & Distribution in combination with Power Generation.

Counting both singles and combinations, all but one Technical Committee received at least one election and two received more than 100 elections, namely Transmission & Distribution and Electronics. Each Division had some broad elections on a Division-wide basis.

Interestingly, the total of elections for the three weak-current Divisions was almost as large as that for the heavy-current Divisions, respectively 800 and 900.

Chairman of Technical Committees and Divisions will be kept aware of the interest expressed in their various entities so that they may take whatever action seems appropriate in further fostering Institute Technical Groups.

Electrical Interference in Low-Level Circuitry Studied

A subcommittee of the Recording and Controlling Instrumentation Committee is being formed to evaluate criteria for control system circuitry with power levels aproximating 10^{-18} watts.

Today's control systems use arrays of closely packed complex electric equipment. A-C systems between 60 and 1,000 cps are predominant. Dozens of wires with different signal levels are crammed together.

The question to be studied by the subcommittee is: What maximum allowable in-phase error, quadrature, and harmonic voltages should be established in circuitry of low power levels?

Those interested in this project should contact: J. E. Casey, Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia 44, Pa.

U. S. National Committee Initiates Planning for Participation in 6th WPC

THE U. S. National Committee of the World Power Conference (WPC) has initiated planning for participation in the 6th Plenary Meeting of the conference to be held in Melbourne, Australia, October 20-26, 1962. At its annual meeting in Washington, D. C., on January 23, 1961, the U. S. Committee appointed a committee on papers to select authors and subjects for the technical papers to be submitted by the United States at the Melbourne meeting.

Twenty technical papers have been allotted to the United States by the Australian National Committee, which will be host for the 1962 meeting. A list of the papers showing titles, authors, and a brief outline of the scope of each paper is to be furnished the Australian Committee by June 30, 1961.

Theme Concerns Changing Pattern

The theme selected for the 1962 Plenary Meeting is "The Changing Pattern of Power." Development of this theme is expected to emphasize the changes that have taken place in all power production, transportation, and utilization techniques since the 5th Plenary Meeting in 1956, and to include forecasts of expected future developments. The papers and discussions will be grouped as follows:

Division I provides for (a) discussion of energy resources based on the WPC Survey of Energy Resources and the United Nations "J" series of publications, and (b) summaries prepared by each National Committee dealing with past and expected future developments in the exploitation and use of all primary sources of energy.

Division II provides for papers dealing with the production and amelioration of primary sources of energy.

Division III covers the transformation of primary to secondary energy and transportation of energy.

Division IV deals with the utilization of primary and secondary energy with subdivisions determined on the basis of broad classes of user.

Division V will be devoted to economic evaluation of alternative energy sources.

The WPC Survey of Energy Resources, to be discussed under Division I, will be released as a new publication prior to the Melbourne meeting. It replaces the former WPC Statistical Year-Book and will be issued at 6-year intervals on the occasion of each Plenary Meeting.

U.S. Committee Is Representative

The U. S. Committee, one of 59 National Committees from all over the world making up the membership of the WPC, is composed of three major groups of participating members. They are (1) the professional engineering societies, currently including AIEE, the American Society of Civil Engineers, the American Institute of Mining, Metallurgical and Petroleum Engineers, the American Society of Mechanical Engineers, and the American Institute of Chemical Engineers; (2) the industrial, utility, or similar associations, comprised of the Association of Edison Illuminating Companies, the Edison Electric Institute, and the American Gas Association; and (3) the federal and state government bodies, composed of the Atomic Energy Commission, Federal Power Commission, Bureau of Mines and Bureau of Reclamation of the Department of the Interior, the U. S. Army Corps of Engineers, and the Department of Agriculture's Rural Electrification Administration.

The affairs of the U. S. Committee are managed by an Executive Board of nine members, comprised of three members from each of the three major groups. Re-elected for the ensuing year at the January 23 annual meeting were the following national officers: F. L. Adams, chief, Bureau of Power, Federal Power Commission, chairman; and J. N. Landis, vice-president, Power Division, Bechtel Corporation, vice-chairman. The Secretariat for the committee is supplied through the Engineers Joint Council, 29 W. 39th St., New York 18, N. Y. All communications should be directed to the Secretary, U. S. National Committee, World Power Conference, at that address.

WPC Objectives Stated

The WPC, formed in 1924, is a non-government international organization with headquarters in London, England. Its objectives, as stated in its constitution, are "the development and peaceful use of energy resources to the greatest benefit of all, both nationally and internationally, by: (1) considering the potential resources and all the means of production of energy in all their aspects; (2) collecting and publishing data on energy resources and their utilization; and (3) holding conferences of those concerned in any way with surveying, developing, or using energy resources." The conference's International Executive Council, whose present chairman is Sir Vincent de Ferranti of England, meets annually in various cities of the world to carry on the continuing business of the organization. Plenary Meetings of the WPC are held every 6 years and Sectional Meetings every 2 years.

Membership in a National Committee is not a prerequisite to participation in the technical meetings of the WPC, but all participants must register through their National Committees. Interested parties in the United States should write to the U. S. National Committee for any information desired on plans for participation in the Melbourne meeting. Copies of the technical program are now available and registration forms for attendance may be obtained sometime in 1961 when they are received from the Australian National Committee.

Certificate of Appreciation Presented

SPEAKER at the February 13 meeting of the Philadelphia Section, AIEE, F. R. Barnett (left), director of research at Richardson Foundation, was presented with a Certificate of Appreciation for his talk from Philadelphia Section Chairman R. L. Halberstadt, who presided at the meeting. Approximately 175 persons attended the meeting.

ATTENDING the Eta Kappa Nu banquet, given in honor of the outstanding young electrical engineers for 1960, were (*left to right*) W. B. Green and R. R. Johnson, who received honorable mention; J. C. McPherson, chairman of the Jury of Award who held the award plaque; T. H. Thompson, who was given honorable mention; and K. H. Olsen, winner of the Eta Kappa Nu Recognition Award.

Outstanding Young Engineers Honored at Eta Kappa Nu Banquet

THE Eta Kappa Nu banquet to honor the outstanding young electrical engineers was held on January 31 at the Governor Clinton Hotel. K. H. Olsen, who received the award of "Outstanding Young Electrical Engineer for 1960," was presented with a replica of the recognition award bowl. Honorable mentions were given to W. B. Green, Greensburg, Pa.; R. R. Johnson, Phoenix, Ariz.; and T. H. Thompson, Basking Ridge, N. J. Following the presentations, a talk was given by H. S. Black, pioneer in the field of negative feedback, on "Why We Need Engineers as Well as Scientists." Albrecht Naeter, president of Eta Kappa Nu, acted as toastmaster and announced that next year's dinner will commemorate the Silver Anniversary.

K. H. Olsen

The 1960 Eta Kappa Nu Recognition Award to K. H. Olsen carried the following citation: "By virtue of his notable contributions to the field of digital computer technology, his administrative competence, and his unselfish participation in church activities." The importance of his accomplishments was outlined by Prof. J. W. Forrester. Mr. Olsen received B.S. and M.S. degrees in electrical engineering from the Massachusetts Institute of Technology in 1950 and 1952, respectively. As a graduate student, his activities included the invention and analysis of the characteristics of a magnetic matrix switch for use with coincident current magnetic memories. Later, while at the Lincoln Laboratories, Mr. Olsen became one of the leaders in the joint program conducted by International Business Machines Corporation and the Laboratories in the development of computers for the SAGE Air Defense System. In 1957, he founded and became president of the Digital Equipment Corporation.

In acceptance of the award, Mr. Olsen gave sound business advice in four categories: (1) Charge enough for the product to be sold; (2) Be sure to charge the know-how that went into development; (3) Avoid the easy dollar; and (4) Include the cost of sales—many engineers do not know how expensive sales costs are.

In conclusion, Mr. Olsen declared that the public has no way of scientifically measuring prices; however, they have certain ways arising from such factors as growth, financing a car, the prices of stock, and profits. The purpose should be to make a long-term profit. The speaker said that enthusiasm makes up for a lot of mistakes.

Honorable mention was made to W. B. Green, with the citation: "By virtue of his highly creative work in the field of semiconductor devices, his activity in training and his unstinted devotion to the church."

R. R. Johnson received honorable mention with the citation: "By virtue of his extraordinary analytical and technical competence in computer development, his managerial ability and his active participation in community and professional affairs."

Honorable mention was given to T. H. Thompson with the following citation: "By virtue of his outstanding contributions in missile guidance technology, his high quality of leadership and his selfless service to church and community."

Each of the award recipients briefly responded from their experiences. Their backgrounds and accomplishments were given in brief biographies published in *Electrical Engineering*, December 1960, pp. 1066-7. The chairman of the Jury of Award, J. C. McPherson, expressed appreciation for the honor of serving this endeavor which he considered extremely worthwhile. W. B. Groth, chairman of the Award Organization Committee, paid tribute to the work of his group in screening a number of highly qualified proposed candidates for recognition awards.

Engineers and Scientists

The role of the engineer was exemplified in a talk, "Why We Need Engineers as Well as Scientists," by H. S. Black of the Bell Telephone Laboratories, Inc. The speaker pointed out that when traveling in the city by train or on a streetcar, more than science is needed to make the trip. Engineers must organize new technologies and advance the old. Science alone cannot advance without an advanced technology. No one appreciated the engineers more than those scientists who worked on radar and on the atom bomb. These developments, however, created the misimpression somehow that science changed the world without the engineer. In conclusion, the speaker stated that today industry can survive only through new discoveries. The objective should be to apply all the knowledge possible; therefore, we must have engineers as well as scientists, and engineering can be a challenge professionally, a fact which can be brought home at the high school level.

Featured Speakers Named for Joint Computer Conference

T. J. Watson, Jr., president of International Business Machines, and Dr. Simon Ramo, executive vice-president of Thompson Ramo Wooldridge, Inc., will be the featured speakers at the 9th Annual Western Joint Computer Conference (WJCC) on May 9-11 at the Ambassador Hotel in Los Angeles, Calif.

Mr. Watson will provide the keynote address at the first session of the 3-day conference on May 9. Dr. Ramo will discuss "Future Application of Electronic Intelligence" as the luncheon speaker on May 10. Another prominent speaker will be Dr. Morris Rubinoff, chairman, National Joint Computer Committee, who will speak on May 9.

The WJCC is sponsored by the National Joint Computer Committee representing AIEE, the Institute of Radio Engineers, and the Association for Computing Machinery.

Theme of this year's meeting will be

"Extending Man's Intellect." Exhibitor's displays have been chosen to underscore new applications and uses of automatic data-processing equipment. More than 2,500 persons are expected to attend the meeting and see displays in the sold-out exhibition.

Approximately 70 papers will be presented in 10 sessions planned to cover the full range of present-day computer applications as well as future uses in the expanding field.

Sessions topics include: Information retrieval, pattern recognition, automata theory and neural models, problem solving and learning machines, automatic programming, modeling human mental processes, computers in control, simulation, computers in communications, and large computer systems.

Exhibits will be installed by 55 firms occupying 103 booths in the Sunset and Boulevard Rooms and the Ambassador Ballroom, with an estimated $3 million worth of displays.

The Regency Room will be available for the working press. Typewriters, telephones, refreshments, papers, and news releases will be supplied.

The Press Seminar will be held May 2 at 9:00 a.m. to 2:30 p.m. in the Ambassador to familiarize the press with the general background of computer technology and the conference. A cocktail party and lunch, hosted by the Public Relations Advisory Council, will be held Monday May 9, at 9:30 a.m., with Mr. Watson, and Wednesday, May 10, at 11:00 a.m., with Dr. Ramo.

A special photo session with models is scheduled for 1:00 p.m. Monday, May 8.

Special press briefings by speakers will be held each morning at 10:00 a.m. in the Press Room.

Abstracts, papers, daily news stories, and product stories will be available in the Press Room.

A social highlight will be a cocktail party, Tuesday evening, May 9, in the Embassy Room. The general chairman of the 1961 meeting is Dr. W. F. Bauer, Thompson Ramo Wooldridge, Inc. The vice-chairman is Keith Uncapher, of Rand.

Conference administrator is Dr. Robert Rector, of Space Technology Laboratories.

Arrangements chairmen include: Publications, Glenn Morgan International Business Machines; Hotel, William Dobrusky, SDC; Finance, William Speer, Norden; Public Relations, Sandy Lanzarotta, Datamation; Exhibits, R. H. Hill, TRW; Printing, L. C. Hobbs, Aeronutronic; Trips, Joel Herbst, Telemeter Magnetics; Women's Activities Mrs. Phyllis Huggins, Bendix Computer; and Registration, Marvin Howard, TRW.

Aircraft Society Contributes to UEC

Rothschild

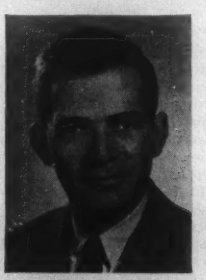
CONTRIBUTION of a $2,000 check for the United Engineering Center (UEC) Building Fund was made December 13 by the Aircraft Electrical Society (AES), Los Angeles Section. Shown are: *(left to right)* Fred Foulon, AIEE junior past chairman; J. D. Andrew, president of the AES who presented the check to H. A. Lott, chairman of the member-gifts campaign of the Los Angeles Section; Carlyle Smith, AES vice-chairman, and Robert Milmoe, Section chairman. AES, through joint membership and sphere of interest, is closely allied with the Aero-Space Division of the Los Angeles Section, AIEE.

Lehigh Valley Section Meets with Other Engineering Societies

A combined winter meeting of the Lehigh Valley Section, AIEE, the American Society of Mechanical Engineers (ASME), and the Reading Subsection of the Institute of Radio Engineers, was held January 13 at the Abraham Lincoln Hotel, Reading, Pa. Attending this combined meeting were 265 engineer members from the three societies, approximately 160 of whom were from the Reading area.

J. W. Lothrop, senior member of the Avco-Everett Research Laboratories, Everett, Mass., spoke on the topic, "Magnetohydrodynamics," as applied to power generation. He described the progress made by his company in the development of this new form of energy conversion. Problems associated with design, materials selection, and the control of the machine were discussed.

An additional highlight of the evening was the presentation of a fellowship award from the ASME to R. M. Homan, vice-president and chief engineer of Gilbert Associates, Inc., of Reading. The fellowship presentation was made by J. G. Miller, assistant chief engineer of the Metropolitan Edison Company, Reading.



J. W. Lothrop

The large attendance at this highly successful meeting pointed up the value and advantages of joint meetings, a desirable aspect of unification, and is expected to enable the attraction of more top flight speakers.

Fourteen industries located in the Lehigh Valley Section area co-operated in providing cocktails served prior to the dinner portion of the meeting.

EMC Survey Shows Rise in Engineers' Salary Levels

Engineers' salary levels rose approximately 5% per year between 1958 and 1960, according to a survey conducted by the Engineering Manpower Commission (EMC) of Engineers Joint Council. The over-all median annual salary now stands at $9,600. The recent increase of 5% may be compared with an average annual increase of 6½% between the years 1953-58.

Seven years ago (1953), the first in this series of surveys found the median salary for engineers at $6,500. These findings were made public recently by EMC in the fourth of a series of surveys, entitled "Professional Income of Engineers—1960," which covers approximately 200,000 engineering graduates in industry, education, and government.

The report which was announced by Dr.

S. B. Ingram, newly elected chairman of EMC, also shows that engineers are a young group, with a median age of about 32, based on a graduation average age of 22. Salaries increase more during the early years of an engineer's career and begin to slow down at about 20 years of experience. Recently, this tendency has been less pronounced.

There is a marked difference between engineering salaries in industry, government, and education, with the highest level in industry, followed by education and government. Of particular note is the 14.3% increase in the total professional income of engineering teachers between 1958 and 1960.

EJC's report contains data on engineer's salaries in 22 subdivisions of industry, comprising 164,657 engineers including separate curves for all-industry Ph.D, Sc.D, and M.S. graduates. Also covered are engineering salaries in all levels of government, which includes 20,491 engineers, separated into federal, state, and local categories, more than 5,000 college teachers, technical institute teachers, and engineering societies. In fact, the report covers about a quarter of the engineering force of the United States.

Earnings of engineers continued their upward trend, observed in the previous survey intervals 1953-56-58. The over-all median for all graduates was $6,500 in 1953, $7,750 in 1956, $8,750 in 1958 (about 6.5% annually), and $9,600 in 1960 (up about 5% annually). The latter represents an increase from mid-1958 to mid-1960. For this same 2-year span, the Consumer Price Index rose 2.3% and the average Gross Weekly Earnings for Production (Manufacturing) climbed close to 8.9%.

A summary of income data, median income, is provided, as follows:

Annual Earnings (Medians)

Years Exp.	*All*	*Industry*	*Educ.*	*Govt.*
1	6,725	6,775	5,375	6,275
5	8,100	8,200	7,350	7,175
10	9,875	9,975	9,100	8,750
15	11,000	11,250	10,950	9,075
28	12,450	12,575	12,575	10,650

Copies of the report are available from the Engineering Manpower Commission, 29 W. 39 St., New York 18, N. Y., at $3 a copy and slightly lower in bulk.

Conference To Be Held April 11-12 on Materials Handling

The 1961 Materials Handling Conference will be held in the Pick-Congress Hotel, Chicago, Ill., April 11-12.

The subject matter at three sessions will deal with vehicle and shipboard material handling, conveyors, and cranes.

For detailed information pertaining to the program and a proceedings booklet of the conference to be made available later, write to: R. S. Gardner, Assistant Secretary, Technical Committee Activities, AIEE Headquarters, 33 W. 39th St., New York 18, N. Y.

Personnel Group Holds Annual Meeting

Vani-Wells-Fagliano

THE Annual Meeting of the San Francisco Advisory Committee of the Engineering Societies Personnel Service, Inc. (ESPS), was attended by: (*Left to right, seated*) Eric Salo, American Society of Mechanical Engineers, newly elected chairman; B. L. Raffin, American Society of Civil Engineers (ASCE), retiring chairman; E. V. Noe, AIEE, and A. H. Meyer, executive director, ESPS; (*left to right, standing*) L. L. Wise, Engineers Club of San Francisco; Heino Jogis, ASCE; W. C. McCulloch, American Institute of Mining, Metallurgical and Petroleum Engineers; Morris Weitzner, Society of Naval Architects and Marine Engineers, and J. R. Decker, manager, San Francisco Office, ESPS.

After-College Professional Development of Young Engineers Is Stressed by ECPD

ENGINEERS are costly for society to produce. They are expensive to maintain. Their output is important to our continued growth, to our high standard of living and, in these times particularly, to the safety of our country. It is most important that this valuable resource be used to its maximum.

The process by which a young engineer is effectively fitted to a job can be a short one or a long one but, in any case, it involves three steps:

1. Finding the job.
2. Learning the job.
3. Growing in the job.

Finding the right job needs attention. Because of the rapid development of science the problems of adapting a particular capability to a particular task, both of which are changing rapidly, is formidable. Learning the job after one gets it may be routine but keeping up is not. Someone has said that the half life of an engineer's education is 15 years. If this is true the technical deterioration of a man's education is at the rate of 3% a year. If we are not to lose this technical capability, a constant effort must be made to keep our people abreast of the times and also working on those jobs for which they continue to be best fitted. This effort must not be left to chance nor made exclusively dependent on good motivations or the judgment of our young engineers, but it must also be purposely planned and fostered by responsible executives in industry, professional organizations, and colleges.

Building Blocks Listed

The Committee for the Development of Young Engineers of the Engineers' Council for Professional Development (ECPD) has addressed itself to these purposes. The building blocks of the plan are:

1. Career Orientation
2. Continuing Education
3. Professional Identification
4. Responsible Citizenship
5. Selected Reading
6. Personal Appraisal

The means of implementation are through community action, through action of the professional societies, through industry and its training and professional development programs, and through schools, particularly those concerned with night classes and graduate activity.

A wide distribution of literature which ECPD has prepared and discussions of the points brought up in this literature is expected to go far toward doing the job. Information on ECPD's publications can be obtained by writing to: Engineers' Council for Professional Development, 29 W. 39th St., New York 18, N. Y.

"Faith of the Engineer"

ECPD has recommended the reading of the "Faith of the Engineer," of which some excerpts follow:

"I am an Engineer. In my profession I take deep pride, but without vainglory; to it I owe solemn obligations that I am eager to fulfill.

"As an engineer I will participate in none but honest enterprise.

"My skill and knowledge shall be given without reservation for the public good.

"I will not shrink . . . from disclosing the truth regarding anyone that by unscrupulous act, has shown himself unworthy of the profession.

"I dedicate myself to the dissemination of engineering knowledge, and especially the instruction of younger members of my profession in all its arts and traditions."

Copies of "Faith of the Engineer" may be obtained from ECPD, which has suggested its framed placement on office walls, so that others may observe the motivation of a good engineer and be encouraged accordingly.

"Faith of the Engineer" is intended to remind an engineer and his associates that the status of a profession depends on its constant adherence to high ethical standards, to a sense of public duty, to the profession's willingness to police itself, and finally to the profession's need for improving its specialized capabilities.

Symposium Scheduled on Biomedical Engineering

Sixteen technical papers will be presented in four half-day sessions at the Symposium on Biomedical Engineering, scheduled for April 20-21 at the El Cortez Hotel, San Diego, Calif.

The symposium is being sponsored by AIEE's Committee on Electrical Techniques in Medicine and Biology, the San Diego Naval Hospital, and the Institute of Radio Engineers' Professional Group on Biomedical Electronics.

The purpose of the symposium is to present technical information on recent progress resulting from co-operative efforts of the biomedical and physical sciences, to highlight areas where such efforts can be even more fruitful in the future, to remove artificial barriers, and to promote better understanding between the disciplines.

Highlighting the meeting will be a banquet Wednesday evening, which will be followed by a panel discussion of what can be expected from interprofessional effort in the future.

A $10 registration fee will include a copy of the *Proceedings*. The banquet will be optional at additional cost.

1961 Washington Award Is Presented to President of Illinois Telephone Company

W. V. KAHLER (M '39, F '46), president of Illinois Bell Telephone Company in Chicago, Ill., has received the 1961 Washington Award, one of the nation's outstanding honors for engineers.

Mr. Kahler was selected by the Washington Award Commission, representing AIEE, American Society of Civil Engineers, the American Institute of Mining, Metallurgical, and Petroleum Engineers, the American Society of Mechanical Engineers, and the Western Society of Engineers (WSE). WSE administers the award. V. E. Gunlock, chairman of the Chicago Transit Authority, is chairman of the Washington Award Commission.

The Commission chose Mr. Kahler "for distinguished leadership in business and civic affairs and for exceptional service to education and humanity."

The award was presented at the Washington Award Banquet, Thursday, March 2, in the Furniture Club of America by R. D. Maxson, president of WSE.

Mr. Kahler, who started his telephone career in 1922 as an engineering assistant with Bell Telephone Laboratories in New York, has been with Illinois Bell since 1924. He was named president in 1951.

The Washington Award was established in 1916 by the late J. W. Alvord, partner in Alvord, Burdick & Howson, engineers, and WSE past president. It was named after George Washington, first U. S. President, and is conferred upon "an engineer whose professional attainments have pre-eminently advanced the welfare of mankind."

Previous Recipients Named

Former President Herbert Hoover was the first recipient in 1919 for his work as chairman for Belgian Relief (1914-17) and as United States food administrator (1917-18).

Among other winners are: Mr. Alvord in 1926; Orville Wright, airplane inventor, in 1927; C. F. Kettering, inventor and General Motors Corporation executive, in 1936; Ralph Budd, former president of the Chicago Burlington & Quincy Railroad, in 1941; the late Henry Ford in 1944; Vannevar Bush, former president of the Massachusetts Institute of Technology (MIT) and famed scientist, in 1946; H. T. Heald, former president of Illinois Institute of Technology and now head of Ford Foundation, in 1952; Gustav Egloff, late director of research for Universal Oil Products Company, in 1953; Dr. J. R. Killian Jr., president of MIT and adviser to President Eisenhower, in 1959.

Mr. Kahler, WSE president in 1947-48, was born in Mendon, Mo., in 1898. He graduated from the University of Missouri in 1922 with a degree in mechanical engineering.

In 1954, Mr. Kahler helped bring the captured German submarine, U-505, to Chicago as an addition to the exhibits at the Museum of Science and Industry.

From 1940-43, during World War II,

W. V. Kahler

he was "on loan" to various federal agencies in Washington and was director, Bureau of Construction, for the War Production Board.

He was exhibits chairman for the 1959 meeting in Chicago of the National Association for the Advancement of Science.

In 1957, Mr. Kahler foresaw that engineering know-how could help develop devices useful in medical research. As a result, Service Activities of Volunteer Engineers (SAVE), an organization of Illinois Bell engineers, was formed. Cooperating with doctors, SAVE has developed, or is studying, a score of research tools to combat cancer, heart disease, and infant deaths, and to provide other medical improvements. SAVE groups are spreading throughout the country.

Mr. Kahler is a trustee of the Illinois Institute of Technology, the Museum of Science and Industry, the Chicago Planetarium Society, the University of Chicago, MacMurray College in Jacksonville, Ill., and the Natural History Museum.

He is a member of the Illinois Civil Defense Advisory Council and the Chicago Central Area Committee, and a director of Illinois Bell.

He received a University of Missouri honor award for distinguished service in engineering in 1951; in 1953, an honorary doctor of engineering degree from Rose Polytech Institute at Terre Haute, Ind.; in 1954, a distinguished public medal from the U. S. Navy; and in 1958, a special citation of merit from Chicago City Junior College "for outstanding service to the City of Chicago and particularly in the field of education."

K. H. Platt Appointed Secretary of English Institution

K. H. Platt, deputy secretary of the Institution of Mechanical Engineers in England, has been appointed secretary of the Institution as of June 1, 1961. Mr. Platt will succeed B. G. Robbins, who was appointed secretary on January 19 but submitted his resignation in order to re-

Joseph Nettis

PANEL members, top men from the McGraw-Hill Publishing Company, are shown sitting at the foot of the Benjamin Franklin statue in Franklin Hall, with members of the audience listening attentively. The panel discussion was held at a joint meeting of the Philadelphia Section, AIEE, and IRE.

tire before reaching the normal retiring age.

Mr. Platt was educated at Shrewsbury School and the University of Glasgow, where he graduated with the B.Sc. degree and first class honors in mechanical engineering. After receiving his practical training and gaining experience in industry, he became a lecturer in mechanical engineering.

During World War II, he served in Malta and held the rank of major. After the war, Mr. Platt was again associated with engineering education and training, both in industry and with the Ministry of Education.

He joined the Institution staff in November 1952, was appointed assistant secretary in May 1953, and deputy secretary in January 1956. He became an associate member of the Institution in 1937 and transferred to member in 1953.

Dr. Humphreys Appointed President of the Cooper Union

The appointment of Dr. R. F. Humphreys as president of the Cooper Union for the Advancement of Science and Art in New York City has been announced by I. S. Olds, chairman of the Cooper Union trustees. A leading scientist in the nuclear field, Dr. Humphreys is now vice-president of the Armour Research Foundation of the Ilinois Institute of Technology, Chicago, Ill.

Dr. Humphreys succeeds Dr. E. S. Burdell as head of the 101-year-old Cooper Union, which is the nation's oldest tuition-free private college of engineering, art, and architecture. Dr. Burdell retired in February 1960, to become president of the Middle East Technical University in Ankara, Turkey, after 22 years as director and president of the Cooper Union.

Dr. Humphreys, who will assume his new position on June 1, 1961, joined Armour in 1949. He has been assistant director and vice-president for technical development at the Foundation since 1956. During 1940-49, he was a member of the physics faculty at Yale University.

As a physicist, Dr. Humphreys has gained a widespread reputation as an expert in the areas of ultracentrifugation of isotopes, cyclotron research, and nuclear reactions. It was largely through his efforts that the Armour Research Foundation was able to enter the nuclear reactor field and to install the world's first reactor for industrial research.

Dr. Humphreys has served as acting director of the Sloane Physics Laboratory at Yale and also consultant on underwater sound research for industry and the government. He is co-author of a textbook on "First Principles of Atomic Physics," and has published papers in *Physical Review*, *Review of Scientific Instruments*, and numerous other scientific journals.

A Rector scholar at DePauw University, Greencastle, Ind., he was awarded a bachelor of arts degree in physics in 1933. He received his master's degree from Syracuse University in 1936 and his doctorate from Yale University in 1939. He is a native of Greenville, Ohio.

Active in civic affairs, Dr. Humphreys is chairman of the radiological defense committee of the Chicago Civil Defense Corps and has served as a member of the isotopes advisory committee to the health commissioner. He is a director and past president of the Physics Club of Chicago.

Panel Discusses Impact on Engineering Management

Some 250 AIEE and IRE (Institute of Radio Engineers) members and guests assembled in Franklin Hall of the Franklin Institute in Philadelphia, Pa., on January 23 to attend a dinner meeting and panel discussion, sponsored jointly by the Philadelphia Section, AIEE, and IRE. There they heard a panel of top men from the McGraw-Hill Publishing Company discuss and answer questions from the floor on major national economic trends and their impact on engineering, scientific, and technical management.

A conclusion which can be formulated from the over-all commentary presented during the panel discussion is:

The economic trend, in terms of its impact on engineering, scientific, and technical management, is toward greater selectivity of engineering talents. Specifically, there is a need for more creative engineering and for less handbook engineering. Regardless of foreign competition, the creative aspects present in the chemical and electronic industries will foster expansion and new products that are competitive in the world market. This year, the electric utilities industry continues to show its strong growth at a rate of $4.9 billion annually. Steam generating units for 800,000-kw units are on order, and 1,000,000-kw units are feasible and will be needed shortly. All these factors strongly emphasize the need for creative talents in engineering, scientific, and technical management.

Denver Section Honors Its Past Chairmen at Meeting

Past chairmen of the Denver, Colo., Section of AIEE were honored guests at the January meeting of the Section, held at the Engineers Club, in Denver.

Since receiving a charter in 1914, 46 prominent Denver area electrical engineers have headed the local organization which now numbers 700 members. The present chairman of the Denver Section is W. L. Smith of the Allis-Chalmers Manufacturing Company.

Featured speaker at the meeting was W. G. Evans, manager of thermoelectric projects for Westinghouse Electric Corporation, Pittsburgh, Pa. His subject was

W. G. Evans

"A Thermoelectric Omnibus." Mr. Evans designed the first Westinghouse magnetic amplifier voltage regulator for aircraft in 1952, and has magnetic voltage reference equipment on the atomic submarine Nautilus. In 1958 he directed the design and manufacture of the first thermoelectric refrigeration apparatus.

"Household thermoelectric refrigerators could be competitive with present ones by 1970," predicted Mr. Evans. Thermoelectricity is just emerging from the laboratory into commercial and military applications.

"One of the promising new uses for thermoelectricity is in satellites and space vehicles, where the sun's energy can be converted directly into electric power," he stated. Thermoelectric generators are applicable in outlying remote areas, and are available in ratings from 5 to 100 watts.

AIEE PERSONALITIES

C. F. Abt (AM '36), formerly assistant research manager of the Arma Division, American Bosch Arma Corporation, Garden City, N. Y., has been promoted to manager of the research department. He succeeds **Bernard Litman** (AM '42, M '48), who has been appointed to the division's newly created scientific staff.

E. Ackerlind (AM '35, M '42) has joined the research and development staff of Lynch Communication Systems Inc., San Francisco, Calif. Dr. Ackerlind will be engaged primarily on new systems design. Since 1957, he had been an electronics consultant for private industry.

T. C. Arnold (AM '57) of Montreal, Que., Canada, has been appointed zone sales manager for Onan Products in Canada. He has the responsibility for sales of all Onan Products in the following 8 provinces: New Brunswick, Newfoundland, Nova Scotia, Manitoba, Prince Edward Island, Quebec, Ontario, and Saskatchewan.

L. D. T. Berg (AM '45), manager of the equipment marketing department of Air Reduction Sales Company, a division of Air Reduction Company, Inc., of New York City, has been elected chairman of the Arc Welding Section of the National Electrical Manufacturers Association.

C. R. Billman (AM '53) has been appointed vice-president of manufacturing of Simpson Electric Company, Chicago, Ill. He was formerly with the H. K. Porter Company of Pittsburgh, Pa., where he served as assistant to the president and general manager of their National Electric Division.

J. R. Coffin (AM '24, F '59), formerly senior vice-president, has been named president of Jackson & Moreland, Inc., consulting engineering firm of Boston, Mass.

H. W. Collins (AM '22, F '48, Member for Life), assistant to the manager of system development for the Detroit Edison Company, retired January 1 after 41 years of service with the company. Mr. Collins started with Detroit Edison as an inspector in 1919. He rose through a series of engineering posts to become head of the company's electrical system department and served in that capacity for 9 years before being named to the staff of the manager of engineering in 1954. Five years later, he was placed on special assignment with the manager of system development to direct engineering studies relating to future expansion of power plants and other electric power facilities.

J. A. Davis, Jr. (AM '30, M '40), vice-president in charge of El Paso Electric Company's New Mexico operations for the last 13 years has been promoted from the division office in Las Cruces to the company's El Paso, Texas, headquarters. **J. F. Armstrong** (AM '44, M '45) has been appointed general engineer at El Paso, to succeed Mr. Davis in Las Cruces in charge of the New Mexico operations. **N. C. Peyton** (AM '47), assistant general engineer, has been promoted to general engineer. **C. M. Olsen** (AM '54), transmission engineer, has been promoted to the position of assistant general engineer. **Peyton Nichols** (AM '50), assistant to the vice-president of operations and engineering, has been promoted to the new position of system co-ordinator in the distribution department.

G. M. DeVito (AM '57), has been named assistant to the manager—construction marketing, of I-T-C Circuit Breaker Company. He was formerly in the switchboard sales department as application engineer.

F. B. Dickey (AM '49) has been named to the newly created position of manager—Magnet Wire Division of Anaconda Wire and Cable Company. He will have full responsibility for marketing Anaconda magnet wire products, directing magnet wire field salesmen, and for establishing magnet wire sales policies and prices.

Dale Dowis (AM '48) has been named to fill the newly created position of chief application engineer at IMC Magnetics Corporation, Western Division, at Maywood, Calif. Mr. Dowis joined the company in 1953.

M. A. Forrest (M '58), vice-president of Burns and Roe, Inc., New York City engineers and constructors, has been elected to the company's Board of Directors. Mr. Forrest has been with Burns and Roe since 1947.

J. C. Monroe (AM '52) has been appointed chief applications engineer at Datex Corporation, Monrovia, Calif.

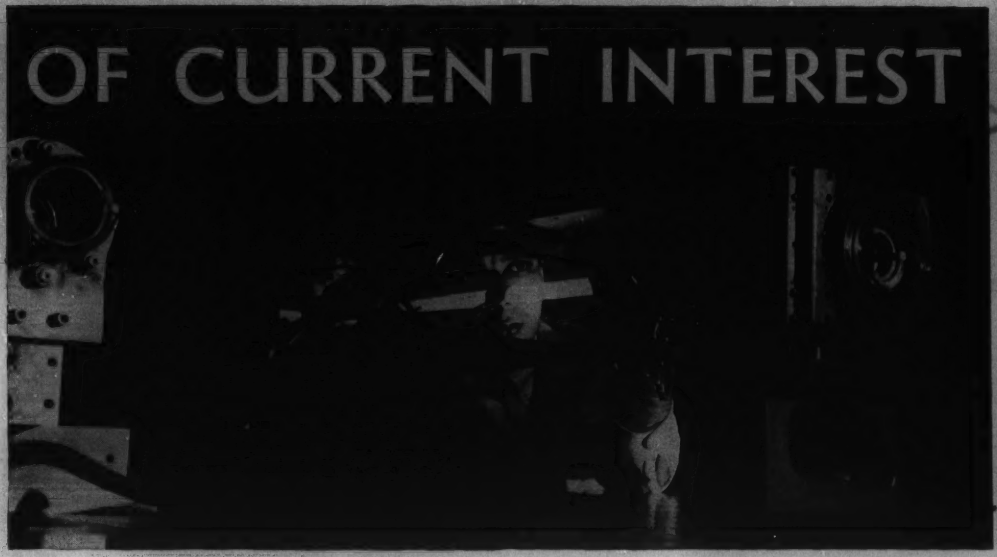
OBITUARIES

Samuel Andral Ferguson (AM '41, M '49), vice-president and general manager of the Mountain View Operations, Sylvania Electronic Systems, a division of Sylvania Electric Products, Inc., Mountain View, Calif., died February 4 at the age of 44. Born January 20, 1917, in Columbia, S. C., he received the B.S. degree in electrical engineering in 1938 from Clemson College, and the M.S. degree in electrical engineering in 1940 from Tulane University. In 1940, he joined the graduate student training course at Westinghouse Electric Corporation, East Pittsburgh, Pa. Mr. Ferguson served as a lieutenant colonel with the Army Signal Corps in World War II. He was recalled to active duty in 1950, and for 2 years was commander of the Signal Corps Field Station at White Sands, N. Mex. In 1946, he was a sales engineer for Westinghouse, and in 1947 became associate professor of electrical engineering at the University of South Carolina. He was assistant technical director of the DuMont Laboratories in Los Angeles, Calif., until he joined Sylvania in 1953.

Harley Otis Murphy (M '37), retired manager of power construction, Tennessee Valley Authority (TVA), Chattanooga, Tenn., died recently. He was born June 24, 1890, in Huron, Ind. During 1912-17, he was employed by Stone & Webster Engineering Corporation, Boston, Mass. He served in the U. S. Army Engineer Corps during World War I. His career with TVA began in 1934 as principal construction engineer with the Division of Power Engineering and Construction. In 1941, he became chief of power construction, and in 1950 he was elevated to power construction manager and served in this capacity until his retirement in 1959. Mr. Murphy was responsible for the transmission lines and substations connecting all the hydro and steam plants throughout the 80,000 square miles of the TVA. He also represented the East Tennessee Section on the Chattanooga-Hamilton County Planning Commission.

Donald McLaren Simmons (AM '22, M '26, F '28, Member for Life), retired, of Sewickley, Pa., died recently. Born July 29, 1889, in New York City, he was educated at Princeton University from which he received the A.B. degree in 1911 and the electrical engineering degree in 1913. He joined the Standard Underground Cable Company in Pittsburgh, Pa., in 1913 and continued with the company until 1927, when it was joined with other companies to form the General Cable Corporation in New York. He was engaged in engineering problems in connection with transmission and distribution. In 1928, he became director of High Voltage Engineering in this company and was made chief consulting engineer in 1930. Mr. Simmons served on the following AIEE Committees: Transmission and Distribution (1930, 1932-43, 1950-54, chairman 1933-35), Technical Program (1933-35, 1940-41), Publication (1935-42, chairman 1940-41), Planning and Co-ordination (1940-41), and Award of Institute Prizes (1940-41).

OF CURRENT INTEREST



▲ Dr. A. Javan, proposer of Bell Laboratories' optical gas maser, inspects heart of unit—a 40-inch tube filled with helium and neon. Interactions between gas atoms produce coherent beam of infrared light that may one day be used to carry vast numbers of telephone conversations and television programs.

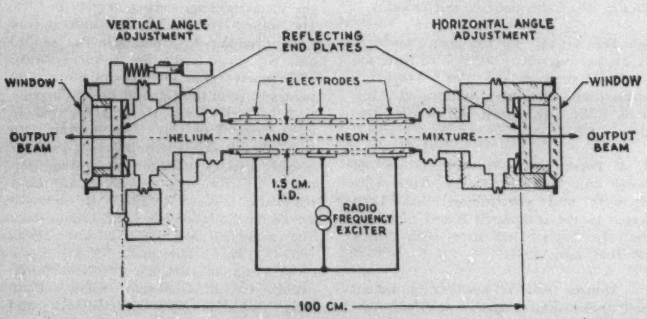
Continuously Operating Optical Maser Is Triumph of Basic Physical Research

THE achievement of a continuously operating optical maser, a goal long sought by many industrial and academic research laboratories, was announced recently by scientists at Bell Telephone Laboratories, New York, N. Y. In contrast to all the intermittent or "pulsed" optical masers announced heretofore, the new system takes a radically different approach, using a gaseous discharge to achieve continuous operation.

Also, instead of being excited by a high powered flash of light, the gaseous optical maser receives its energy from an electrical discharge of very low power. The coherent beam of radiation lies in the infrared portion of the spectrum, and is thus invisible except through a "sniperscope" or similar converter.

The spectral line width of the output beam is a hundred thousand times narrower than that from other coherent light sources. This property has permitted the observation—for the first time—of difference-signals at radio frequencies between two optical lines.

The operation of this device was described by Drs. A. Javan, W. R. Bennett, Jr., and D. R. Herriott, of Bell Laboratories, in the February 1 issue of *Physical Review Letters*, a publication of the American Physical Society. Basic physical principles of gaseous optical masers were previously described by Dr. Javan in the same journal in July 1959. These principles are considerably more sophisticated than those which apply to the solid-state optical masers.



Gaseous Optical Maser

The ruby optical maser depends for operation on an external bright light to "pump" the chromium atoms in its crystal structure into an excited upper energy level. These excited atoms then emit their energy as coherent light.

The gas maser uses a mixture of helium and neon gases through which an electrical discharge flows, in the same way as in a conventional neon tube. The energy from the internal discharge excites the helium atoms to a very high upper "metastable" energy level, from which they normally would not radiate energy.

The neon atoms in the mixture collide with the excited helium atoms, and the energy is transferred to them through the collision process. The neon atoms themselves then can be stimulated to radiate their energy on demand in a continuous stream. The beam is reflected back and forth through the length of the gas-filled tube by semireflecting end plates, growing in intensity with each trip. Some of the beam is transmitted through the plates, and forms a very narrow output beam of coherent infrared light.

During this stimulated radiation of energy, some of the neon atoms also drop into lower energy levels, spontaneously emitting the reddish-yellow light typically associated with normal neon tubes.

The power required to excite the maser action is in the tens-of-watts range. The output power is in the 1/100-watt range. At this level of operation, the tube is so cool that it can be held in the hand without discomfort. The level of operation can be increased by using larger diameter tubes.

Optical gas masers and optical solid-state masers are expected to complement each other in their applications. The latter maser, being essentially a high-power device, will have important uses even if limited to pulsed operation.

Since the neon atoms can radiate energy from almost any one of four upper energy levels to one of ten intermediate levels, up to 30 discrete frequencies can be emitted by the maser, depending on the specific mode of operation. The range of possible wavelengths lies between 9,000 and 17,000 Angstrom units. Present laboratory models have operated at five different wavelengths between 11,000 and 12,000 Angstrom units.

The output line width is far sharper than that of ruby masers. The light emitted by the ruby devices is about 60 times narrower than the ruby's normal fluorescence. Normal fluorescence from the helium-neon mixture is already as narrow as that, and maser action narrows the beam more than one hundred thousand times more. Thus, the line is thousands of times sharper than the best spectroscopic lines available in the optical region.

Other gas mixtures are expected to produce different output frequencies with comparable success to that of the helium-neon mixture.

The gaseous optical maser should provide physicists with an immensely useful tool. The narrowness of the line will afford an accuracy hitherto unattainable in spectroscopic work at these frequencies.

Another possible application of the device is the measurement of distances of many miles with extreme accuracy. Continuous optical maser action, moreover, is stimulating renewed interest in the whole field of gaseous-discharge physics.

EE

Radio Interference Eliminated With Special "Hi-Mu" Tape

U.S. Navy scientists from the Naval Civil Engineering Laboratory at Port Hueneme, Calif., have been successful in eliminating radio interference from power lines by coating the lines with a special "hi-mu" tape, Captain A. B. Chilton, CEC, USN, Commanding Officer and Director of the laboratory, has announced.

The laboratory team headed by Physicist D. B. Clark, completed a series of tests at Fort Huachuca, Ariz., on 12 miles of high-power electrical transmission lines that have been described by the laboratory as a highly significant achievement in radio interference elimination.

The tests prove conclusively that the usage of the high permeability tape coating on the lines will effectively control unwanted electromagnetic interference.

The Navy laboratory believes that the special tape can be produced commercially at a low cost and that it will meet a vital need of all the military services and be a great service to the general public.

Only recently the necessity of finding an effective means of harnessing radio interference from power lines and generating equipment was pointed out by Admiral Arleigh Burke, Chief of Naval Operations, as "a major problem and one of great concern to the Navy." Electromagnetic interference has been the source of trouble in certain missile and satellite launchings by the United States. It also could result in an enemy-fired missile striking a critical location which produces excessive electromagnetic radiation.

EE

New Ice Age Predicted —Within 90,000 Years

The climatic factors which produced the ice ages, the most recent of which ended only about 10,000 years ago, are still active, and a new icecap from the pole to Peoria is imminent.

Imminent, that is, in the time scale of a geologist—within 30,000 to 90,000 years.

This conclusion was presented by Dr. R. W. Fairbridge, Columbia University professor of geology and co-chairman of a recent international conference on solar variations, climatic change, and geophysical problems.

Dr. Fairbridge's prediction was qualified somewhat by the outside possibility that there may occur a shift of the poles—a passing disaster which has occurred before with results of interest to future geologists but disconcerting to those in a position to observe it firsthand.

Thereafter, instead of a relatively immediate new ice age, there could occur a measurable warming-up of the world as the present Antarctic icecap melted.

If the new poles were both in open ocean, glaciation would be prevented, he said. On the other hand, if both new poles were on continental land masses, glaciation would be widespread.

Dr. Fairbridge termed his paper a discussion of "quantitative paleoclimatology which opens a new frontier in earth science, extending back more than 50,000 years."

Carbon dating, study of deep-sea cores, of magnetized rocks, of annual sedimentary deposits now preserved in stone, and of fossilized pollens provide techniques and data which make paleoclimatology possible. With them and others, climatic cycles varying from 11, 22, 40, 80, and 189 to 567 years have been identified.

These cycles relate, at least in part, to periodic rise and fall in sunspot numbers, Dr. Fairbridge said, and to the earth's magnetic field and to planetary motions, such as the position and angle of the earth in relation to the sun.

Another factor influencing the cycles, and producing dissimilarities between the northern and southern hemispheres, Dr. Fairbridge explained, is the fact that 95% of the earth's glaciers sensitive to warming or cooling of a few degrees are in the northern hemisphere, as are the major land masses of the world.

Future Meetings of Other Societies

ASTM, Symposium on Materials and Electron Device Processing, Apr. 10-12, Franklin Institute, Philadelphia, Pa. American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

PIEA-PESA, Conference and Equipment Exhibit, Apr. 11-13, Galveston, Texas. Petroleum Electric Supply Association, 1334 Fidelity Union Life Bldg., Dallas 1, Texas.

Institute of Radio Engineers
Symposium on Information and Decision Processes, Apr. 12-13, Purdue University, Lafayette, Ind.
2nd National Symposium on Human Factors in Electronics, May 4-5, Marriott-Twin Bridges Motor Hotel, Arlington, Va. IRE, 1 E. 79th St., New York 21, N.Y.

Cleveland Engineering Society, Machine Design Conference, Apr. 14, Cleveland, Ohio. Same, 3100 Chester Ave., Cleveland 14, Ohio.

AWS, 42nd Annual Meeting and Exposition, Apr. 17-21, Hotel Commodore and Coliseum, New York, N.Y. American Welding Society, 33 W. 39th St., New York 18, N.Y.

Conference on Organic Semiconductors, Apr. 18-19, Morrison Hotel, Chicago, Ill. Armour Research Foundation, Technology Center, Chicago 16, Ill.

SWIRECO, 13th Annual Conference and Electronics Show, Apr. 19-21, Dallas, Texas. Southwestern Institute of Radio Engineers, P. O. Box 7443, Dallas 9, Texas.

Illinois Society of Professional Engineers, 76th Annual Convention, Apr. 20-22, Peoria, Ill. W. C. Redd, 1108 E. London Ave., Peoria, Ill.

NARM, 9th National Conference on Electromagnetic Relays, Apr. 25-27, Oklahoma State University. National Association of Relay Manufacturers, Same.

AIME, International Symposium on Agglomeration, Apr. 12-14, Sheraton Hotel, Philadelphia, Pa. American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc., 29 W. 39th St., New York 18, N.Y.

7th Aero-Space Instrumentation Symposium, Apr. 30-May 4, Adolphus Hotel, Dallas, Texas. Aero/Space Instrumentation Symposium, P. O. Box 321, Arlington, Texas.

Overseas

The Engineering, Marine, Welding & Nuclear Energy Exhibition, Apr. 20-May 4, London. A. Seligman, 9 Malcolm Rd., London, S.W. 19, England.

1st International Television Festival, May 15-27, Montreux, Switzerland. Mark Associates International, 501 Madison Ave., New York 22, N.Y.

IMEKO Conference, June 26-July 1, Engineering Societies Building, Budapest, Hungary, J. Johnston, Jr., President of ISSA, Dupon de Nemours, Wilmington 98, Del. or IMEKO Secretariat, Budapest 5, P.O.B. 3.

United Nations Conference on New Sources of Energy, Aug. 21-31, Rome, Italy. A. G. Katzin, Executive Secretary, United Nations Conference on New Sources of Energy, United Nations, New York, N.Y.

Rassegna Internazionale Elettronica, Industrial and Commercial Exhibit, Aug. 21-31. Via della Scrofa 15, Rome. (Organized by "Rassegna"—not United Nations or the Italian Government). Same.

Alaska Dredge Is Electrically Streamlined

THE DREDGE *ALASKA*, built at the Houston, Texas, plant of Todd Shipyards Corporation for the Great Lakes Dredge and Dock Company, Chicago, Ill., with an electrical system designed by the General Electric Company, is one of the largest hydraulic dredges built in recent years.

Courtesy Todd Shipyards Corporation

ALASKA, a new dredge, bristling with the most up-to-date electric equipment that powers its cutter 85 feet below the surface, has been delivered to Great Lakes Dredge and Dock Company, Chicago, Ill.

Constructed by Todd Shipyards, Houston, Texas, the 208-foot craft is electrically streamlined with the latest static-type a-c reactor control, specially designed heavy-duty d-c motors, and instrument panels illuminated with ultraviolet light. It will be able to dig deeper than any dredge in the world.

General Electric engineers designed the nearly half-million dollar electrical system that includes stepless control from a-c power for the ladder hoist and spud hoist drives, and d-c power for the cutter and winch operations.

The decision to employ the a-c reactor control system was based upon ability of the system to provide close speed control for high accuracy plus the economic advantages of using less expensive a-c rotating equipment.

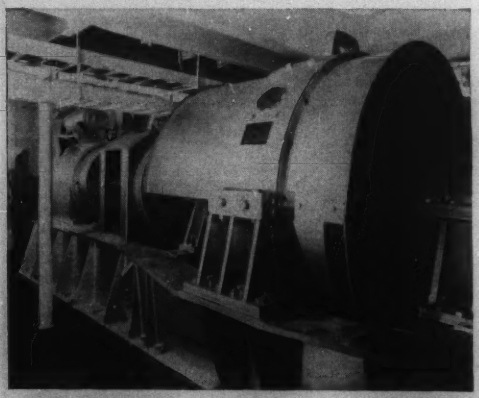
Officials of Great Lakes Dredge and Dock Company estimate that the use of stepless a-c reactor control on the ladder hoist and spud drives alone will reduce maintenance expenses by 75%.

Completely stepless speed control of the spuds and 100-foot ladder can be achieved with the reactor controlled a-c drive system. Drive motor for the ladder hoist is a 200-hp, wound rotor induction motor with primary reactors, secondary reactors, and secondary resistors. The spud hoist is similar except with a 150-hp drive motor.

Power for the pilot house is tapped off the *Alaska's* a-c system. Unique feature of the pilot house is ultraviolet illuminated instrument panels. This use of "black light" on ammeters, voltmeters, and speed indicating instruments eliminates glare from the windows caused by conventional lighting.

Prime mover for the d-c power supply is a 2,700-hp Cleveland Diesel engine. This engine turns a 1,250-kw d-c generator which powers the two 600-hp cutter motors. These heavy-duty mill-type motors are mounted on the ladder and are coupled to the gear unit which in turn is coupled to the 14-inch cutter drive shaft.

It was necessary for General Electric to custom build the twin-cutter motor drives. They are designed to operate efficiently



DIESEL-DRIVEN generator lineup on *Alaska* dredge consists of 1,250-kw d-c generator (*right*) providing power for cutter drive motors, 500-kw a-c generator (*middle*) providing power for ladder and spud hoists plus auxiliary power, and 200-kw d-c generator (*far left*) with top-mounted exciter providing power for the swing winch.

General Electric Company Photos

ABOVE: Ladder hoist and swing winch drive equipment on dredge *Alaska*. In foreground at left is a GE type-MR 250-hp motor with brake for driving ladder hoist, and at right is a 40-hp jacking motor for ladder hoist. Motors for winch are located in background. *Photo at right:* Over-all view of spud drive machinery. At center of the upper section, GE type-MR 150-hp motor with brake drives spud hoists. On the wall at rear, GE resistors and saturable reactors provide spud drive control.

when the ladder is tilted to its maximum of 60 degrees, exposing the motors to splash and spray under rough weather conditions.

These motors are similar to the heavy-duty types used in steel mill applications. They are blower ventilated with high overload and high operating temperature characteristics, and are capable of withstanding extreme mechanical shocks typical of cutter drives.

In addition to smooth speed control, the custom-built d-c adjustable voltage control panel is used to help protect the cutter drive shaft from breaking under high torque conditions. As heavy overload conditions increase, an amplidyne senses the increased current and automatically limits the torque developed by the motors.

A 200-hp d-c motor, with entire speed range supplied by armature voltage control and field control, drives the lineshaft for the winch and boom drives.

General Electric also supplied 25 auxiliary a-c motors for driving pumps, fans, machine tools, grinders, lathes, etc.

EE

Superconducting Wire Promises Ultrahigh Magnetic Fields

RESEARCH scientists at Bell Telephone Laboratories have demonstrated the feasibility of superconducting solenoid magnets producing extremely high magnetic fields. They utilized a superconducting compound of niobium and tin (Nb_3Sn), fabricated and reacted by special metallurgical techniques.

Although it has been realized for many years that it is possible to produce magnetic fields with superconducting solenoids, the materials that have been tried in the past would only sustain fields of a few thousand gauss. At larger magnetic fields the superconducting properties disappear. With the new compound, steady-state magnetic fields of 88,000 gauss are possible.

Additionally, a superconducting solenoid does not require expenditure of electric energy once the field is established, whereas a solenoid of ordinary metal will use large amounts of energy. Nb_3Sn becomes superconducting at 18 Kelvin, a higher transition temperature than any other superconductor presently known. This compound was first discovered at Bell Telephone Laboratories in 1954. Until the present, however, its critical field had not been measured. Since the material is extremely brittle, it was not possible heretofore to use the niobium-tin compound in the construction of a solenoid (coil magnet).

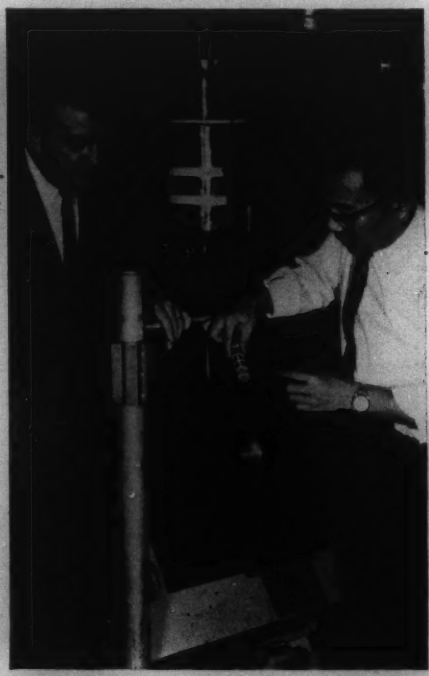
Indications are that the niobium-tin material will sustain fields of 100,000 gauss while carrying electric currents of 100,000 amperes per square centimeter of cross-section.

This new breakthrough in the field of cryogenics (low temperature research and development) resulted from new metallurgical arts, plus experimental and theoretical knowledge of the physics of solids. J. E. Kunzler, E. Buehler, F. S. L. Hsu, and J. H. Wernick of the Laboratories staff discussed these findings in the February 1, 1961 issue of *Physical Review Letters*, a publication of the American Physical Society.

The unusual behavior of Nb_3Sn at high fields raises many questions for physicists about the nature of superconductivity.

This new material development will have important applications wherever large volumes of magnetic fields are required. Important applications in the field of communications are envisioned. Many electronic devices require magnetic fields for their operation. Among these are traveling wave tubes and masers. The availability of large magnetic fields can extend the operation of these devices to higher frequencies providing the possibility of broadband communication systems for use in earth-based radio-relay systems and active satellite repeaters for space communications.

Another attractive application is the containment of thermonuclear fusion plasmas for the production of electric power.



RIGHT: Frank Hsu points out to Gene Knuzler (*left*) the way leads are ultrasonically soldered to a molybdenum-rhenium (Mo_3Ro) superconductive solenoid magnet. Weighing only a few ounces, the solenoid magnet held produces a magnetic field of 15,000 gauss without consuming electric energy. The new niobium-tin (Ni_3Sn) superconductive solenoid magnet, though larger in size and weighing more than this one, will produce magnetic fields of at least 88,000 gauss. The cryostat and conventional electromagnet in background were used at Bell Laboratories to develop the molybdenum-rhenium superconductive solenoid magnet. Temperatures in the range of liquified helium are used in the cryostat, while the conventional electromagnet associated with it produces fields up to 18,000 gauss (between poles). *Above:* Eugene Berry is shown with furnace used to bake experimental magnetic coils. The process is part of a discovery which is expected to produce very strong magnets which operate on very small amounts of electric power. The experimental samples are contained in a metal tube which is heated red hot by an r-f coil contained in an evacuated bell-jar.

Bell Telephone Laboratories Photos

A third important area is in the experimental physics laboratory where the cost of producing high magnetic fields has greatly limited the experimental physicist. This new materials discovery will make high fields available to a wider community of scientists throughout the world.

To illustrate the simplification in magnet design that this new development will make possible, a superconducting electromagnet can be compared to a more conventional magnet using copper as the conductor. Such a conventional magnet presently in operation at Bell Telephone Laboratories requires a power supply and cooling equipment which literally fills several rooms. While in operation it uses thousands of gallons of cooling water per hour and consumes 1.5 megawatts of electric power; this is 25% of the total amount of power consumed at the Murray Hill facility, Bell Laboratories' center of research where over 4,500 people are employed. By contrast, a superconducting solenoid magnet of Nb_3Sn, and producing a comparable field, would not consume any electric energy once the flux is established. **EE**

Pilot Can "Talk" to Base With New Push-Button Unit

Development of a push-button communications device that enables a jet pilot to "talk" to his base with greater speed, more accuracy, and assurance that his message will cut through heavier atmospheric disturbance was disclosed recently by Hughes Aircraft Company.

Called "Digikey" by its inventors, the device permits a pilot or crewman to "talk" through heavy electrical interference at a rate of 150 words per minute (twice normal speed) by punching keys on a small semi-automatic keyboard, R. E. Wendahl, Hughes vice-president, said. He called it "so simple that anyone can be trained to operate it in a matter of minutes."

Digikey was recently installed in a Strategic Air Command (SAC) aircraft and subjected to a week-long airborne evaluation by SAC officers and technicians.

Digikey converts a message into digital form and transmits through a communications system to a ground station where the digits are reconverted into words and displayed in printed form on a receiver unit, Mr. Wendahl explained. Large volumes of information can be sent in a short time with reduction in chances of human error or ambiguity.

The operation of the system was described as follows:

A belt, or roll chart, on which message words are printed, covers the keyboard with words directly over the keys. The operator is, in effect, given a "multiple choice" and selects a word from the first group displayed and punches that key, registering the word in the system's memory. The belt advances to a new set of words and another message is selected. At the same time other information from the aircraft's instruments is being recorded in the memory. On completing the message the operator presses a "transmit" button and the message is automatically broadcast as many times as desired.

A weather report was cited as an example:

The operator would punch a "weather report" key. Digikey would automatically transmit the aircraft's call letters and identification from the system's memory, the plane's position, heading and altitude as furnished by the ship's instruments.

The keyboard would advance to display a section of words to describe the nature of the weather such as "moderate winds," "poor visibility," "electrical storm" and the like. The next display would describe precipitation, then cloud formations, the latter illustrated by "pictograms," symbols illustrating the formulations.

The ground receiver would display the information, including the pictograms.

Other displays would depict air battle situations, surface contact information and emergency conditions.

One of the applications of Digikey is its use with the Hughes-built long-range communication system, "Hacon," now operational with the U.S. Air Force's B-58 Hustler supersonic bomber.

Digikey and a digital converter allow Hacon to "talk" digits as well as voice. The difficulty of communicating through heavy electrical interference is overcome by breaking up a message into a series of coded electrical pulses which are transmitted over several frequencies. Only a few pulses need to get through for the receiver to recognize the character transmitted.

Information from a large number of aircraft can be fed directly into automatic command and control systems for data processing because there is no need to translate the digits into computer language. **EE**

NEW communications device called "Digikey" by its Hughes Aircraft Company inventors, enables a jet pilot to "talk" to his base by punching indicated panels. Panel pictured above indicates different types of surface contacts observed by pilot. Weather, combat situations, and emergency conditions also may be transmitted. Engineer R. J. Harris demonstrates transmission panel. Communications are twice as fast as normal and can penetrate heavy electrical interference.

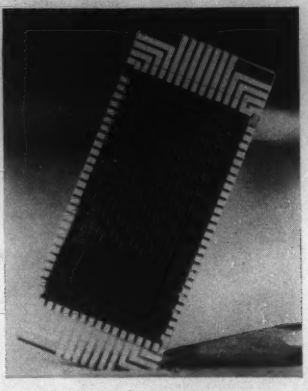
Automatic Process Reproduces Cryogenic Memory Plane

Successful fabrication of a cryogenic thin film memory plane the size of a postage stamp and the development of automatic control techniques capable of duplicating it many times have been announced by the International Business Machines Corporation (IBM).

This makes the first time that scientists have used automatic control techniques to duplicate such a cryogenic unit. The memory plane, consisting of 135 cryotron devices built up in 19 layers of material, was fabricated by scientists at IBM's Federal Systems Division laboratory in Kingston, N.Y., working in conjunction with IBM Research.

Cryogenics, a branch of solid-state physics, is concerned with what happens in materials and devices at temperatures of about —450 F. At such low temperatures the characteristics of certain metals permit electric current to flow endlessly, without additional power, in devices that can be used to perform logic and to store information in a computer memory. Cryotrons are the devices in a cryogenic computer which perform addition, subtraction, multiplication, and division as well as logic, switching, and amplification.

In the device reported by IBM, three cryotrons form a memory cell which combines storage with an elementary logic operation. Because of this combination of functions, sophisticated operations not practical before may be realized. For example, scientists expect this concept may



▶ THIS experimental cryogenic thin film memory plane consisting of 135 cryotron devices built up in a 19-layer "sandwich" and successfully duplicated many times by automatic control techniques was announced by IBM. The memory plane, about the size of a large postage stamp, stores 40 separate pieces or "bits" of information in 120 of its cryotrons. Of the remaining 15 cryotrons, 10 permit access to the stored bits of information; the other 5 are "in-line" cryotrons which switch bits of information from one memory plane to another.

be used in an "associative memory," which simultaneously searches all memory compartments and thereby speeds access to any stored information.

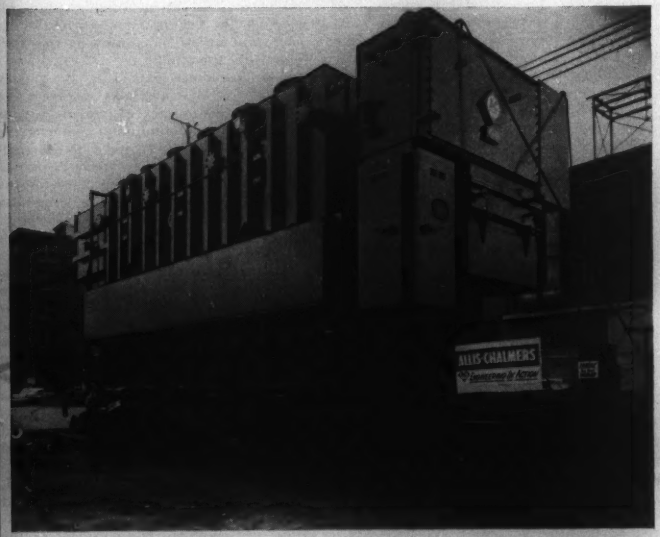
Key to this major advance in cryogenic device devolpment is the special technique which permits accurate duplication of devices. By means of this technique, microscopically thin layers of metals and insulating materials are automatically deposited on a glass substrate.

The equipment used for deposition allows each layer of a metal or insulator to be sequentially deposited through 17 microscopically adjusted masks, or perforated metal sheets. The masks are changed automatically like records in a juke box and are held in a large metal cylinder operating under high vacuum. Once the masks have been properly aligned, the process automatically produces duplicate superconducting memory planes with similar electrical and mechanical characteristics.

Forty separate pieces or "bits" of information are stored in 120 cryotrons in the new memory plane. Of the remaining 15 cryotrons, 10 permit access to the stored bits of information; the other 5 are "in-line" cryotrons which switch bits of information from one memory plane to another. These newer in-line cryotrons operate faster than conventional cryotrons in communicating between the memory planes. They also permit faster communication between the memory planes and the arithmetic portion of the computer. Research is in progress to refine the thin-film fabrication techniques to produce cryogenic devices of even greater speeds

EE

Record-Size Transformer



ONE of the largest generating station transformers in the world is this unit, with an equivalent two-winding capacity of 404,250 kva, shown being shipped from Allis-Chalmers West Allis Works for installation in Commonwealth Edison Company's Crawford Station, Unit No. 8, in Chicago, Ill. This 3-phase transformer's low-voltage winding is rated at 385,000 kva at 12,000 volts. It has two high-voltage windings, each rated 211,750 kva, which will feed two 138-kv systems. Each high-voltage winding has ±10% load tap changing equipment. The unit will be forced oil cooled with oil-to-air heat exchangers. Weighing in at 673,000 pounds installed, the transformer is 36 feet long, 18 feet wide, and 19 feet high. Despite its record size, it was shipped upright on a 250-ton railroad car complete except for bushings, Electro-Cooler units, and insulating oil. This means a minimum of assembly work at the installation, which represents another step in Commonwealth Edison's modernization program at its 36-year-old Crawford station.

Dynastat Memory Aids Unimate Robot

The brain of an industrial robot which may save American industry millions of dollars each year by performing repetitive tasks in factories is a new-type magnetic memory drum.

It is this "Dynastat" memory which gives the Unimate robot its uncanny ability to remember complex work procedures after being led through a sequence only once.

The brainchild of Consolidated Controls Corporation, a subsidiary of Consolidated Diesel Electric Corporation, Dynastat, unlike most other magnetic memory devices, can be "read" while stationary. This property, extensively used in the control of Unimate, makes the drum ideal for a wide range of machine tool and materials handling applications. It can remain stationary, providing a continuous reference signal against which to compare actual movements of the device being controlled. Only after actual movements correspond with those indicated by the drum need the drum step to its next position to indicate a new end-point toward which the machine should move.

As used in Unimate, the magnetic memory drum has a capacity of 16,000 bits of information. These are recorded in 200 rows around the circumference, each row consisting of 80 bits parallel to the drum axis. The 200 rows correspond to the number of distinct movements which Unimate can "remember." The 80 parallel bits per row represent the number necessary to control all of the functions which may be needed for Unimate to make a movement and to actuate auxiliary machinery.

In recording a sequence of movements, Unimate is led by the hand to the first position in the sequence. Shaft-position-to-digital converters generate signals corresponding to this position. A record button is pushed. The record button actuates amplifiers which drive "write" heads which impress a magnetic pattern on the drum. The drum then steps to its next position, ready to receive the pattern corresponding to the next movement of Unimate. This step-and-record sequence

WHILE Unimate, a new industrial work handling machine with a "teachable" memory, introduced by Consolidated Controls Corporation, bears little resemblance to a human being, its arm and memory duplicate those of a person. Its "hands" can be changed to fit a particular job by simply removing two screws. Shown in a variety of operations with different hands, Unimate here uses long, slender fingers to handle small, delicate parts; broad grippers to grasp heavy steel cylinders; double-action, parallel jaws for the assembly of bulky objects, and makes use of its swivel-action "wrist" for the assembly of screw parts.

"TEACHER" of Unimate simply prods the hand to desired positions by applying finger pressure to the white buttons on the temporary teaching control attached to the hand. The end point of each movement is recorded by pushing the "record" button held in his right hand.

may be continued until each row on the drum, 200 in all, indicates a movement for Unimate.

After a sequence has been recorded, Unimate can repeat the recorded movements indefinitely. When its "repeat" button is depressed, the drum steps to its first position. Magnetic "read" heads detect the pattern and initiate movements which will bring Unimate's position into correspondence with the recorded pattern.

While Unimate is moving, signals generated by shaft-position-to-digital converters attached to its joints are continuously compared in a specially designed comparator with the pattern presented by the Dynastat drum. As Unimate nears the end of its movement, the comparator slows the action so as to avoid overshoot and over-stress which might result from an instantaneous stop. When the signals received from Unimate exactly match those from the drum, action is stopped. The drum then moves on to the next step in the routine and the action is repeated until Unimate has gone through its entire "memorized" routine. At the end of the routine, the drum goes immediately back to its starting position, ready to repeat the entire sequence.

EE

Aluminum Industry Celebrates 75th Anniversary

Former White House Press Secretary J. C. Hagerty spoke at the aluminum industry's 75th anniversary celebration at Oberlin College on February 16, joining a roster of leaders in business and the professions who discussed aluminum's role in the world of the future.

The anniversary celebration, sponsored by The Aluminum Association, featured a Round-Table of Tomorrow, on which the panelists included: Philip Sporn, authority on nuclear generation of electric power and president of the American Electric Power Co.; Philip Will, Jr., president of the American Institute of Architects and senior partner in Perkins and Will of Chicago, Ill., and White Plains, N. Y.; and Dr. W. A. Pennington, president of the American Society for Metals and professor of metallurgy at the University of Maryland.

STATUE of Charles Martin Hall, discoverer of the electrolytic reduction process for aluminum, appears in Severance Chemical Laboratory at Oberlin College from which he graduated on July 1, 1885. His discovery was made in the woodshed of his family home in Oberlin 8 months later. Aluminum statue was presented to Oberlin in 1928 by R. B. Mellon.

The observance marked the anniversary of Charles Martin Hall's discovery, in February 1886, of the electrolytic process which first made aluminum commercially abundant. Hall was 22 and a recent graduate of Oberlin College when he scored his triumph, in his clergyman father's woodshed. Before his discovery, aluminum was so rare that jewelry was made of it. Last year, United States production exceeded 2 million tons.

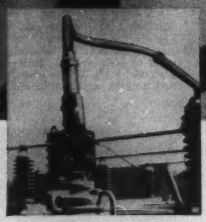
Another feature of the ceremony was the presentation of an aluminum plaque to the College, in token of a permanent aluminum museum display which The Aluminum Association will donate to the College as soon as construction is finished on a new Hall of Science, in which the museum is to be housed. The plaque was presented by E. G. Fahlman, a past president of The Aluminum Association and chairman of the board of The Permold Company, Medina, Ohio.

Oberlin's President, Dr. Robert Carr, welcomed the group to the campus, and M. M. Anderson, president of The Association and executive vice-president of the Aluminum Company of America, presided.

EE

CADWELD

Lug tap off
strain bus cable



Tubing to cable
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Utilities all across the country are utilizing CADWELD copper connections for their tubular bus and overhead strain bus cable. CADWELD having proved itself under the most severe current surge and corrosive conditions in copper and steel grounding systems, is now performing with the same economy and superior quality on overhead power connections.

Illustrated are standard connections of tube to: tube, lug (bus bar) and cable. Also shown in the main photo are CADWELD connections of tube to flexible, laminated, copper jumpers.

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You can cut line voltage fluctuations of ±10% to a mere ±1% with an economical, easily-installed GLENN Line Voltage Compensation Unit.

They're self-contained, convection-cooled units that work automatically and reliably, require little or no maintenance. They are available for all single or 3-phase line voltages to 600 vac, in output ratings to 400 kva (100% duty cycle)—and may be paralleled for higher capacities. Response time is adjustable.

Glenn Line Voltage Compensators pay off wherever line voltage jumps around to upset processing, control, testing or equipment performance. If you have problems like these, why not write us now for detailed information and a quotation?

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New Products

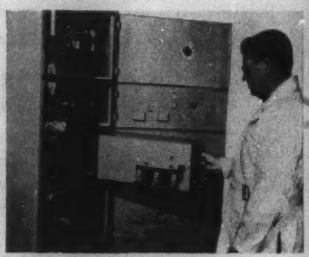
(Continued from page 8A)

New Digital Voltmeter . . .

Stroboscopic readout with the long life and high accuracy of a conductive plastic potentiometer developed by the Markite Corp. are the techniques used in this new, low-cost digital voltmeter. Mounted on the same shaft with the potentiometer, a light shines through the holes aligned with a sequential series of 250 numbers on a drum to a photodiode. This light feeds a series of clock pulses to a flip-flop with pulses so timed that a strobe lamp located inside the drum fires only when a number and projection lens are properly aligned. A standard voltage impressed across the potentiometer generates a sawtooth voltage for each revolution. The unknown voltage is continually compared to this sweep voltage; at the instant the sweep and unknown voltages are equal, the flip-flop is triggered so that the next hole coming into alignment causes the strobe lamp to flash. *Electro-Logic Corp., 515 Boccoccia Ave., Venice, Calif.*

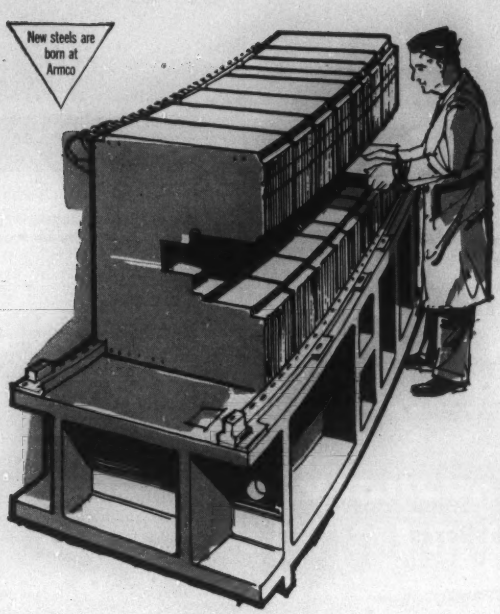
Motor Control Center . . .

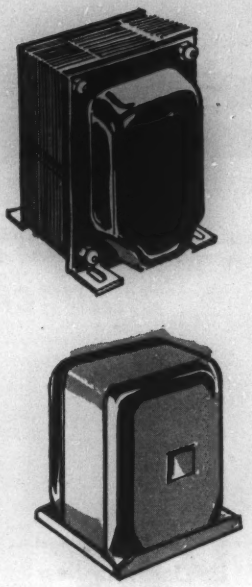
Designed for automation systems, this apparatus features swing-out starters and circuit breakers using permanent wiring for both load and control. In addition, all wiring for load, control, and indication is brought to accessible master terminal blocks at top or bottom. Each starter unit is equipped with fused control transformer, two



extra interlocks, and one special microswitch that provides an extra safety interlock to make sure the contactor is open and all load removed prior to withdrawal of the unit. Combination nonreversing starters through size 4 and circuit breakers through 225 amperes utilize this new construction. *Nelson Electric Mfg. Co., P. O. Box 5385, Tulsa, Okla.*

(Continued on page 28A)





Why Designers of Apparatus, from Accelerators to Electronic Transformers, Use Armco TRAN-COR A-6

Armco A-6 Electrical Steel is specified for a wide range of electrical apparatus because its unique combination of properties best meets design and production requirements.

TRAN-COR A-6 has high permeability, particularly at low and moderate inductions. Minimum permeability of 2150 at 100 gausses is certified. And, every shipment is production tested for this magnetic property.

In addition to excellent permeability, Armco A-6 has low core loss, reasonably uniform properties in all directions, and adequate ductility for punching.

This special Armco Electrical Steel is produced in 29 and 26 gage in welded coils or cut lengths, with or without standard or special Armco surface insulations. Design curves are available to help you make most effective use of A-6. Write us today for complete information. Armco Division, Armco Steel Corporation, 1741 Curtis Street, Middletown, Ohio.

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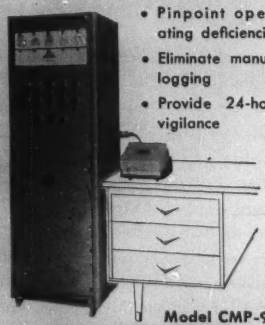
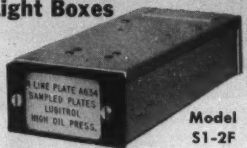


- Pinpoint operating deficiencies
- Eliminate manual logging
- Provide 24-hour vigilance

Model CMP-9921

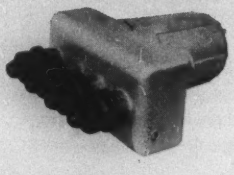
Transformer-Type Light Boxes



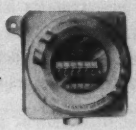
Model S1-2F

- Quickest registration
- Connects directly in control circuit
- Choice of 120 or 6 volt lamps

Explosion-Proof Models



Model EKP-4 provides four separate alarm points.



Model ST-EM static switching type annunciator with six alarm points.

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New Products

(Continued from page 26A)

D-C/A-C Solid-State Inverter . . .

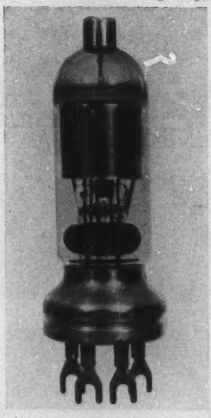
With no moving parts other than two fans, this high-capacity solid-state device does the work of a 60-hp motor-generator set in converting direct to alternating current. A recent laboratory development, this first successfully tested working model has a rating of 50 kva which is ten times the power-handling capacity of units previously announced. Other basic facts include: efficiency—approximately 90%; input—125 volts d-c; output—120 to 240 volts, 3 phase, 50 to 500 cps adjustable $\pm 1/2\%$; output wave form—sinusoidal, less than 5% total harmonics. *General Electric Co., Schenectady 5, N. Y.*

Compact Tower . . .

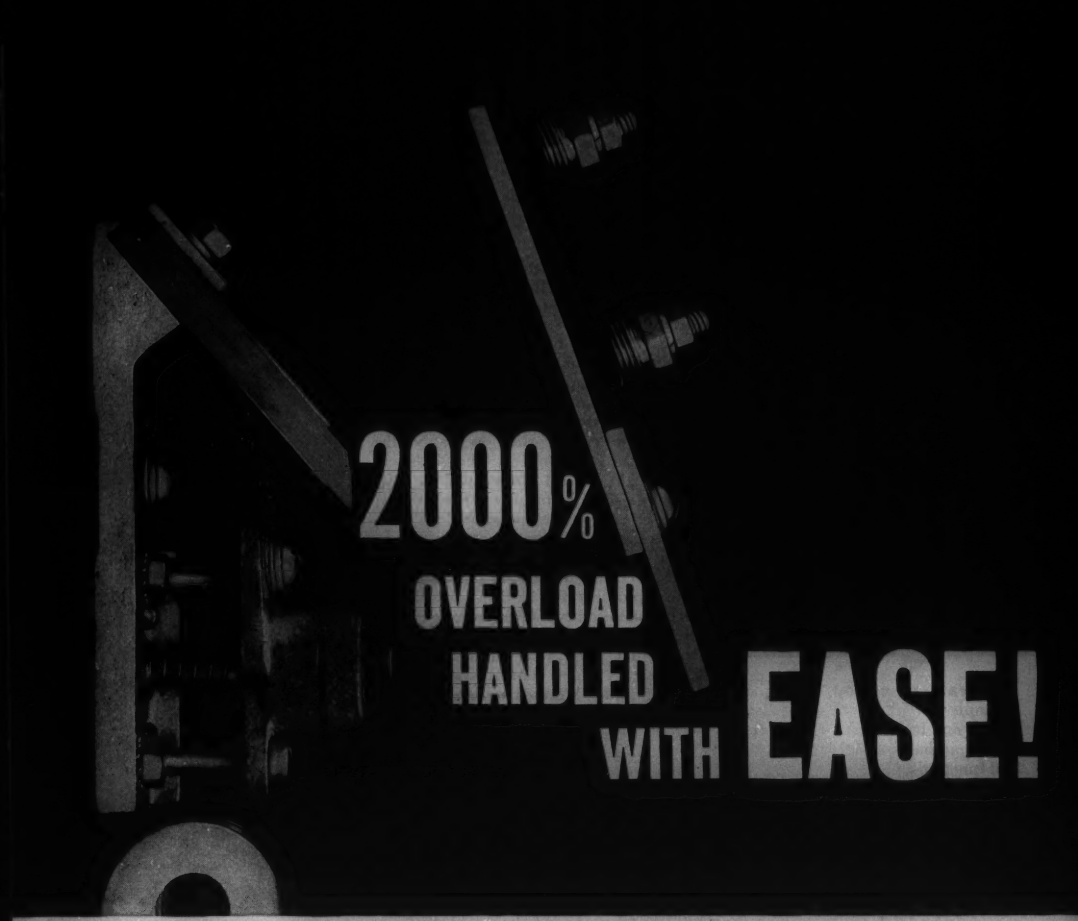
This new development in tower design is composed of struts and ball-shaped joints which can be asembled into octahedral structures with each facet an equilateral triangle. The sections nest for storage in a space approximately one-seventh the height of the tower. The tower is erected by lifting the tower from below and adding additional sections to the base, or by gin-pole method after preassembling the tower on the ground. Sections are made of aluminum alloy, steel or Fiberglas. *Right Towers, 1013 Pardee St., Berkeley, Calif.*

Life Indicating Tube . . .

These new thyratron and diode tubes predict failure 300 hours ahead of time by changing color from normal blue to neon red. Allowing ample time

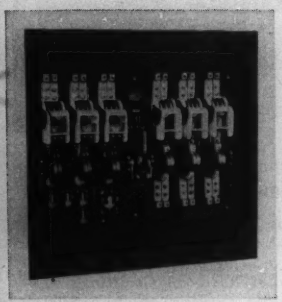


for replacement to minimize machine downtime, the tubes are standard on Reliance *V-S* drives but may be used on many other drives or processes employing thyratron or diodes. *Reliance Electric and Engineering Co., 24701 Euclid Ave., Cleveland 17, Ohio.*



ASCO Automatic Transfer Switches withstand inrush currents over 20 TIMES switch rating

Built to close safely on inrush currents over 20 times switch rating, ASCO Transfer Switches also have the thermal capacity to carry not less than 20 times full load current for one second.



ASCO 3-pole, 1000 AMP., Bulletin 906 Automatic Transfer Switch.

This uniquely high current capacity is made possible by over-all extra heavy construction, positive opening and closing – and by thoughtful design. For example, contact pitting or welding is prevented by: *Separate make and break contacts (pictured), which insure clean current carrying contacts at all times.* ■ *The powerful mechanical movement, which locks contacts in place – tightly and securely.* ■ *Massive silver-to-silver contacts.*

In service, ASCO Switches transfer the load from normal to emergency supply when normal supply fails or is significantly reduced. On restoration of normal supply, the switch retransfers the load.

The extensive ASCO line includes an Automatic Transfer Switch to meet your exact requirements – 30 to 2000 amperes ... to 750 volts, AC or DC. ASCO Switches need not be derated for tungsten lamp loads, for cabinet enclosure, or for continuous 24-hour duty.

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This ram air scoop is another example of AiResearch's ability to design and integrate structural and electromechanical systems for control functions.

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Industrial Notes...

Autonetics
Downey, Calif. . .

Inertial guidance wrote a new chapter in navigational achievement recently with the successful launching of the Air Force Minuteman intercontinental ballistic missile. The 3-stage, solid fueled missile carried full operational type guidance and flight control equipment developed for the Air Force by Autonetics, a division of North American Aviation, Inc. The guidance and flight control system used in this test is almost identical to those which will be used in the operational missiles except for additional instrumentation now needed to obtain data for the Minuteman program. Heart of the guidance problem for ballistic missiles is the establishment of correct velocity vectors relating to the ballistic trajectory. To help accomplish this, the Autonetics flight control system uses the unique Minuteman method of third-stage engine thrust termination which utilizes thrust reversal to separate the re-entry vehicle and place it upon the correct trajectory.

Arnold Engineering Co.
Marengo, Ill. . .

The Arnold Engineering Company has announced the establishment of new, larger facilities to serve users of magnetic materials on the West Coast. The company has purchased a modern, 108,000-square-foot manufacturing plant in Fullerton, Calif., laying the groundwork for substantial expansion of its operations in the area. The Fullerton plant will become West Coast headquarters for Arnold's manufacturing and sales, giving the company about triple the manufacturing plant space it formerly had in Los Angeles.

Sperry Gyroscope
Syosset, N. Y. . .

A $275,000 expansion of a superclean assembly line at a Marine Division plant of Sperry Gyroscope Co., will triple production of critical navigation elements for Polaris missile-launching submarines. The new assembly line, its atmosphere totally free of dust or microbes larger than a ten-thousandth of an inch, will turn out components for inertial navigation systems on submarines designed to fire the longer-range 1,500- or 2,500-mile developmental Polaris missile submarines

of either the Ethan Allen or Lafayette classes.

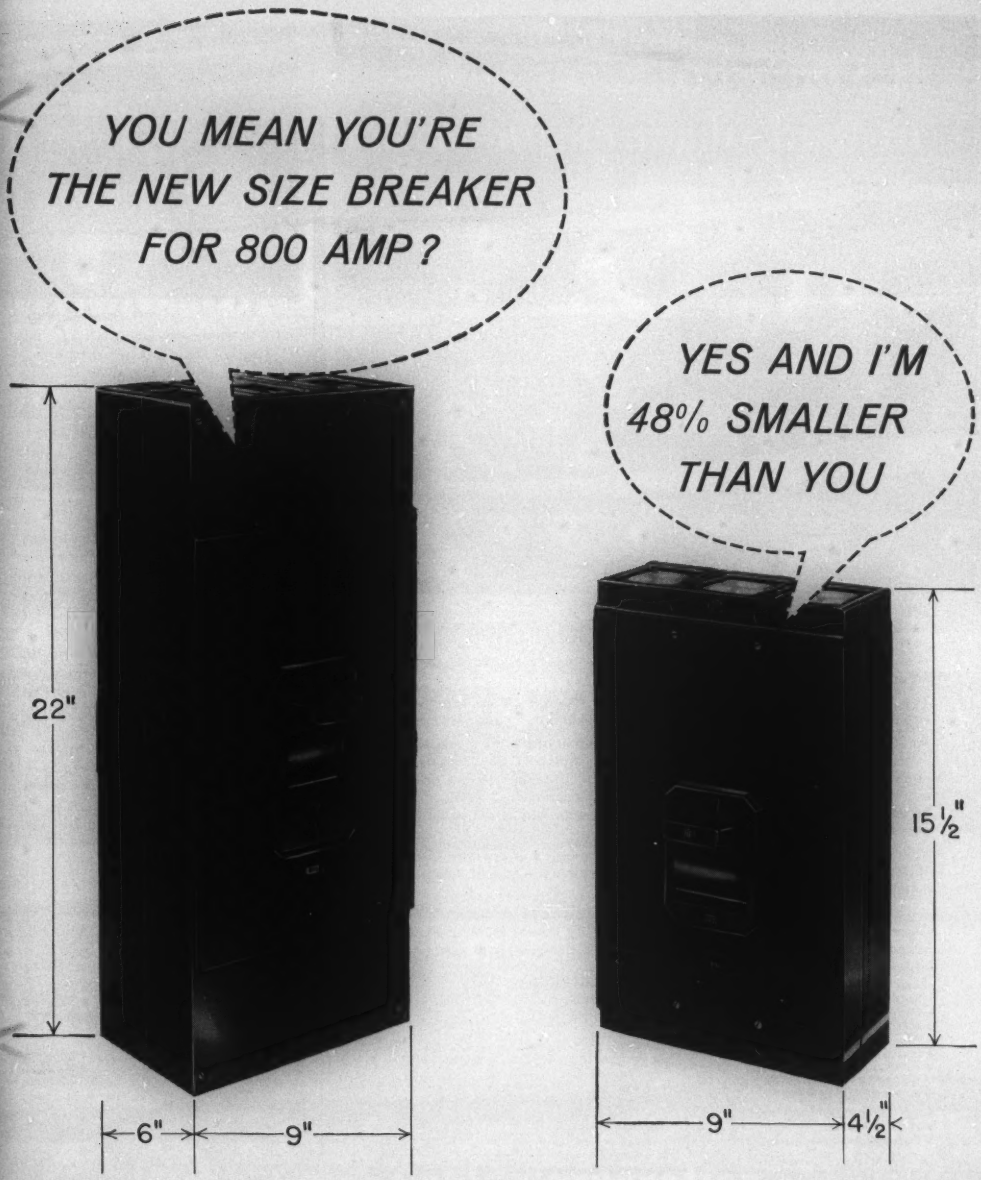
Chemo Products
West Warwick, R. I. . .

Chemo Products Inc., manufacturers of Teflon products, will now use X rays in their final quality control "check point" test. Until now it was difficult to prove that inner material was equal in perfection to the exterior. This rigid X–ray test leaves nothing to chance. The photograph depicts a mold of a mass of Teflon, 12 inches in diameter by 8½ inches long being X rayed.

Raytheon
Maynard, Mass. . .

Nose cones and tail fins to keep the Army's Davy Crockett projectile on target are being produced by the Plastics Plant of Raytheon Company's Aero/Weapons Division under a $300,000 pilot production contract from the Army Ordnance Corps' Picatinny Arsenal, Dover, N.J. Designed to give infantry and armor troops a low-yield nuclear punch at close ranges, the pioneer weapon system can be mounted on a jeep or an armored personnel car-

(Continued on page 32A)



You're darn right 800 amperes. Yet this new I-T-E KM frame circuit breaker shaves 6½ in. off the height and 1½ in. off the depth for this rating. Handles 800 amp continuous, 50,000 amp interrupting at 240 volts, 25,000 amp at 600 volts. Send for full details. Write I-T-E Circuit Breaker Company, Dept. SA, 1900 Hamilton St., Philadelphia 30, Pa.

I-T-E CIRCUIT BREAKER COMPANY

If you were a *surgeon* instead of an *engineer*...

. . . you'd want to work at one of the *leading* hospitals in the nation—where your associates would represent the finest medical talents available. In such a situation you could grow more in a year than in a lifetime spent in an ordinary clinic.

The same thing is true of every profession. Your own stature as an engineer is determined to a great extent by the calibre of your associates.

At Motorola you will be working for and with some of the most respected engineers and scientists in the electronics field—Motorola is an "engineer's company." And, here at Motorola the horizon is wide and the ceiling unlimited—you can go as far—*as fast*—as your capabilities permit. You'll be working for a *secure*, diversified company—not wholly dependent on one single market.

You owe it to yourself and your family to investigate the opportunities at Motorola. Dozens of fields of interest are open—just a few of which are listed below. Write today for the full story.

We'll send you a complete description of "Your Life at Motorola"—in Chicago; Phoenix; Riverside, California; Culver City, California; Minneapolis, Minnesota. Naturally your request will be kept in complete confidence.

- Radar transmitters and receivers
- Radar circuit design
- Electronic countermeasure systems
- Military communications equipment design
- Pulse circuit design
- IF strip design
- Device using kylstrom, traveling wave tube and backward wave oscillator
- Display and storage devices

2-WAY RADIO COMMUNICATIONS
- VHF & UHF receiver
- Transmitter design and development
- Power supply
- Systems engineering
- Antenna design
- Selective signaling
- Transistor applications
- Crystal engineering
- Sales engineering
- Design of VHF & UHF FM communications in portable or subminiature development
- Microwave field engineers
- Transistor switching circuit design
- Logic circuit design
- T.V. circuit design engineering
- Home radio design
- New product design
- Auto radio design
- Mechanical engineering
- Semi-conductor device development
- Semi-conductor application work

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EQUAL JOB OPPORTUNITY For All Qualified Applicants

MOTOROLA inc.

Industrial Notes

(Continued from page 30A)

rier. A lightweight version can be hand-carried and fired from a tripod by a 3-man crew. Moulded from a plastic compound by compression techniques, the nose cones serve as ballistic windshields. Produced in the same manner, the fins have high structural qualities to resist rough field handling and meet performance requirements and are designed to maintain true flight of the projectile.

H. K. Porter
Pittsburgh, Pa. . .

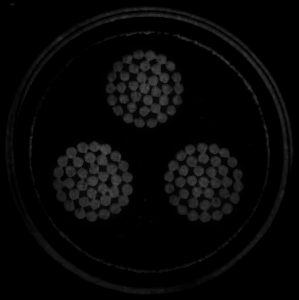
Nepcoduct Underfloor Raceways supplied by National Electric Division of H. K. Porter Company, Inc., were selected for the new El Paso County Office Building at Colorado Springs, Colo., because of a unique junction box which permitted fast placement of ducts. In this modern 6-story building a triple underfloor raceway system will provide full coverage for the power, telephone, and interoffice communications systems in all office areas. Over 15,000 feet of duct with 140 Nepcoduct Triple Duct Junction Boxes will house high- and low-potential electrical systems. The installation features Na-

tional Electric's new "Lazy Susan" NXZ Junction Box which eliminated a major installation problem by allowing fast placement of junction boxes without the worry of time-consuming repositioning problems in the event a box was installed incorrectly. The new NXZ Junction Box with the "Lazy Susan" partition, separating three electrical distribution systems, provides a 360-degree rotation to match duct runs if the junction box is not oriented properly with the system.

(Continued on page 36A)

GENERAL CABLE

INTERLOCKED ARMORED CABLE



General Cable Corporation

REDUCED CORE LOSS... LESS EXCITING CURRENT WITH NEW WESCOR* CORE

New Westinghouse Wescor core combines the improvements in quality and permeability of Hipersil® steel with a newly developed method of forming a series of step-lapped core joints. Result: higher possible working inductions in the magnetic circuit. In fact, core loss is 33% less than equivalent type C core . . . with comparably lower exciting current.

Wescor cores are pretested and shipped from stock in 27 sizes, ranging from 30 to 400 pounds. More details from your nearest Westinghouse representative, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. *Trademark

You can be sure . . . if it's **Westinghouse**

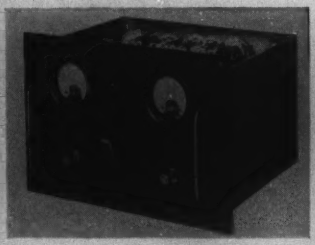
J-70953

Industrial Notes

(Continued from page 32A)

Perkin Electronics El Segundo, Calif. . .

A $350,000 contract for power supplies to be used in shore support and on-board submarine launching of the Polaris missile was recently awarded to Perkin Electronics Corp. The contract calls for more than 300 power supplies. These units are unusual in that they are rated at 10 volts, 5 amperes dual output.



NuTone Cincinnati, Ohio . . .

A range hood that opens for cooking and disappears afterwards has been introduced by NuTone, Inc. A gentle lift opens the hood—a slight push closes it. All that shows is a narrow panel, flush with the wall cabinets, which can match walls, appliances,

counters, or cabinets. NuTone supplies insert panels in clear or copper anodized aluminum as well as 11 decorator colors. A plastic laminate insert can be used to match the counter top.

Edison Foundation New York, N. Y. . .

Establishment of a $3,000-a-year Thomas Alva Edison Fellowship for graduate study of the patent and related systems was announced recently by the Thomas Alva Edison Foundation. This fund will be made available annually to The Patent, Trademark, and Copyright Foundation of The George Washington University, Washington, D. C., for award to a qualified graduate student in one of the schools of the University.

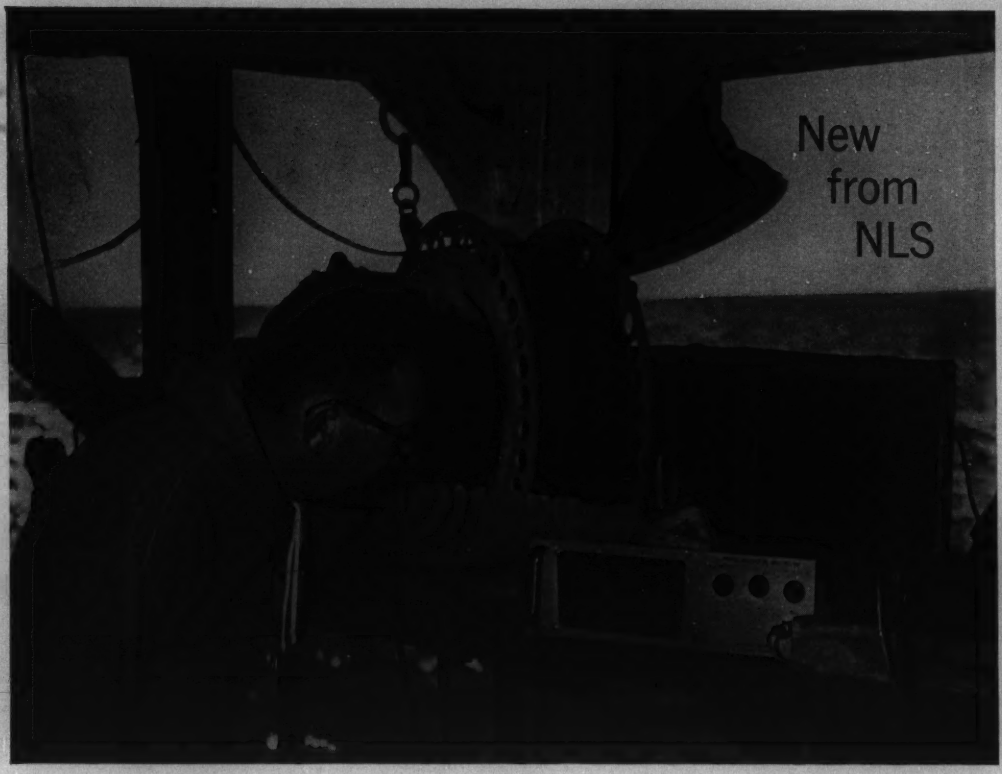
Super-Temperature Wires Winooski, Vt. . .

American Super-Temperature Wires, Inc. a subsidiary of Haveg Industries, Inc., now have a process for printing code numbers or letters on multiconductor cables used in electronic cir-

cuitry. The major advantage of this process is the elimination of color coding of multiconductor cabling. The complicated color stripping is replaced by easy-to-read numbers which all but eliminate the possibility of hook-up error and make for easy identification of the electronic circuits. The Super-Temp engineered process employs special fluorocarbon resin inks which are sintered so that the numbers and/or letters become a permanent part of the Teflon wire insulation.

General Electric Portland, Ore. . .

Twenty-five minutes of flying within a course smaller than an acre was all it took for a Hiller 12E helicopter to erect a new-type metal powerline structure, according to reports of a recent contract completed on a 115,000-volt line for General Electric Co. The job called for the placement of three 63-foot 450-pound aluminum tripod towers to replace wooden poles weighing seven to nine times as much.



The NLS V60 Digital Millivoltmeter is designed for a wide range of scientific, industrial and military applications including strain gage and thermocouple measurements, calibrating millivolt devices, process monitoring, and semiconductor research and testing.

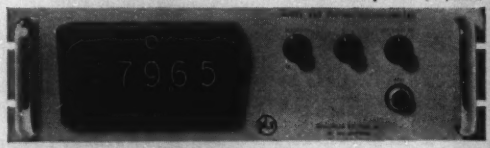
Make precise millivolt measurements at a glance... aboard ship, in the lab, or on the production line

Here is a new, faster, more precise way to make low-level DC voltage measurements. The NLS V60 full 4-digit millivoltmeter makes 80 measurements per minute, average. It features ±0.01% precision (ability to repeat readings within close limits) — unattainable from pointer meters, strip chart recorders or combination of a digital voltmeter and preamplifier. Accuracy of the V60 is ±0.1% of reading or ±10 microvolts, whichever quantity is greater.

A span (scale factor) control allows you to set the V60 to display its reading directly in units of pressure, weight, length, strain, stress, speed, etc. And because the V60 is a *digital* voltmeter, you can read it at a glance from close or afar in total darkness or sunlight, without parallax error.

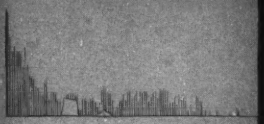
Other features include: very high AC and DC common mode rejection . . . retention of accuracy under adverse conditions . . . range of ±99.99 mv. full scale . . . plug-in stepping switches . . . high input impedance . . . precise internal voltage reference . . . filter to attenuate input signal noise . . . full floating, ground isolated input circuit.

V60 complete $1,625



non-linear systems, inc. *Originator of the Digital Voltmeter*
DEL MAR, CALIFORNIA

ELECTROMAGNETIC COMPATIBILITY ANALYSIS



Here is your opportunity for professional growth in a challenging and extremely interesting field, as a member of an outstanding and stimulating scientific team. Armour Research Foundation, specialist in electronic interference evaluation, is now expanding its facilities and staff requirements in the area of Electromagnetic Compatibility Analysis. We are looking for qualified electronic engineers at all levels (B.S. through Ph.D.) for research and applied studies concerned with system analysis and performance prediction. Immediate openings are available at either our *Chicago* or *Washington, D. C.* area facilities for individuals with experience in one or more of the following fields . . .

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In addition to to the cited professional status, staff members receive attractive salaries, up to four weeks vacation, generous insurance and retirement benefits, and tuition paid graduate study. If you are interested in one of these professional opportunities, please reply in confidence to Mr. R. B. Martin.

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Trade Literature . . .

"Explosion-Proof" Housings . . .

How explosion proof are electrical "explosion-proof" housings? A 4-page bulletin shows results of independent hydrostatic rupture tests. The illustrated bulletin uses a chart to show these test results, as well as a similar Adalet box, Underwriters' Laboratories tested. Also shown are a variety of special instrument and control applications employing standard explosion-proof electrical housing. The Adalet cast aluminum housings are said to be the largest Underwriters' listed explosion-proof boxes offered to the industry. *The Adalet Manufacturing Co., 14300 Lorain Ave., Cleveland 11, Ohio.*

Switch Brochure . . .

"Donner Acceleration Switches For Dynamic Accuracy" is the title of this new 6-page brochure. The illustrated brochure examines the problem of meaningful accuracy in acceleration switches aboard operational missiles. Operation and variations available in the company's acceleration switch are described. Complete technical specifications and company sales offices are listed. *Donner Scientific Co., a subsidiary of Systron-Donner Corp., Concord, Calif.*

Control Relays . . .

Data Bulletin 6235 describes this manufacturer's time delay industrial control relays. The frame-*235* relays have 12-pin plug mountings in heavy-duty sockets. Diagrams are given for dimensions and wiring, and general specifications are also included. *Struthers-Dunn, Inc., Pitman, N.J.*

Inductor Coils . . .

This product bulletin includes charts which serve as yardsticks for the design engineer who seeks an answer in a variable inductor. They may be employed to predict reasonably electrical parameters if form size, wire size, and winding constructions are varied from the set conditions used for the preparation of these curves. All curves are intended to indicate close approximation to average readings. Specifications are broken down by material, normal use, and frequency. *Delevan Electronics Corp., 77 Olean Rd., East Aurora, N.Y.*

Auxiliary Equipment . . .

Three new pamphlets written in catalog style, with complete specifications, performance characteristics, and pertinent illustrations, are available. The 8-page pamphlets give detailed presentation of amplifiers: five models, including rack-mounting and frame-mounting versions; square-wave and pulse generators: four generators, including two designed primarily for the Textronix Pulse-Sampling System; and time-mark and sine-wave generators: four generators, including a rack-mounting model (Time Mark Generator). *Textronix, Inc., P. O. Box 500, Beaverton, Ore.*

Precision Wirewound Resistors . . .

This 4-page 2-color folder describes a line of encapsulated precision wirewound resistors providing exceptionally high performance in small size. Units are built in standard, subminiature, and microminiature sizes, and in conformance with Mil Specs MIL-R-93A, MIL-R-93B, and MIL-R-9444. A special feature is the high wattage rating per physical size, and high resistance value per given volume. Complete specifications and technical data are given, including derating curves, and a curve showing resistance change vs. temperature change. *The Hanjohn Co., Inc., 9834 E. Alpaca St., South El Monte, Calif.*

Power Fuses . . .

Current-limiting power fuses designated *GEA-7137*, are described in an 8-page brochure which gives application information for G-E fuses rated 600 to 34,500 volts, including various mounting arrangements. Publication includes photos, cutaway drawings, and graphs showing components and operational characteristics of type *EJ* fuses. *General Electric Co., Schenectady 5, N.Y.*

Printed Circuit Connectors . . .

Series *600-7* printed circuit connectors are used in missile and rocket ground support guidance equipment, and offer a unique tandem design that combines four groups of printed circuit receptacles in a single 8.63-inch-long molding. Complete technical specifications outline drawings, and illustrations are contained in Form 1260. *Electronics Division, DeJur-Amsco Corporation, 45-01 Northern Boulevard, Long Island City 1, N.Y.*

Scale Recording Voltmeter . . .

Specifications and description of model *1122B-60* expanded scale re-

(Continued on page 40A)

FILM-COATED MAGNET WIRE FOR 220 C

Affords continuous high-temperature operation up to 250 C—resists heat shock up to 425 C

The exceptional heat stability of Anaconda ML Magnet Wire makes it ideal for electrical equipment operating at continuous high temperatures up to 250 C—such as high-temperature motors, relays and dry-type transformers. This same heat-resistant characteristic also makes ML Magnet Wire a valuable tool in miniaturization and in reducing the size of larger equipment.

Tremendous overload resistance (as demonstrated by thermo-plastic flow above 500 C and heat shock resistance over 400 C) makes ML Magnet Wire particularly suitable for portable tool armatures and other applications where "stall" conditions or unusual overloads may be experienced.

Essentially zero weight loss to 200 C makes it possible to use ML Magnet Wire for relays that will operate at temperatures up to 250 C with low space factor and comparatively low cost. Using ML Magnet Wire in sealed relays practically eliminates contact contamination due to "outgassing" of wire insulation.

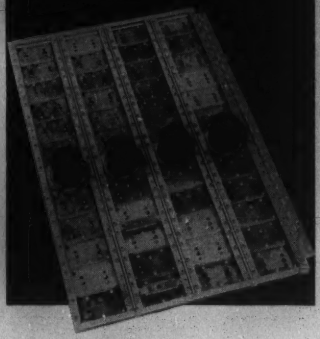
Other ML Magnet Wire advantages: high burn-out resistance and cut-through level; dry dielectric strength over 3,000 V/Mil; excellent flexibility; good windability and scrape resistance.

ML Magnet Wire is coated with a solution of ML Polymer, a new chemical development by duPont that represents a tremendous improvement in heat resistance over organic coatings. ML Magnet Wire can be used as a replacement for most film-coated magnet wires, except solderable types, and many glass and glass Dacron wires. Where the positive inorganic spacing of glass is required, the combination of ML film and glass serving offers outstanding properties. ML Magnet Wire's combination of high temperature rating, excellent winding characteristics and space factor permits its use in many applications which formerly required the use of much more expensive combinations of ceramics and fluorocarbons.

ML Magnet Wire is available in all sizes of round, square and rectangular. Film additions are single, heavy, triple or quadruple thicknesses, all conforming with NEMA specifications. ML also meets all requirements of Spec. MIL-W-583B for Class 180 Types H, H2, H3, and H4, and Class 200 Types K, K2, K3, and K4. For prices, technical data and applications engineering information, contact Department EFL-1-EE, Anaconda Wire and Cable Company, 25 Broadway, New York 4, New York.

ASK THE MAN FROM
ANACONDA®
FOR ML MAGNET WIRE

Environmental conditioning *for* *detection systems*



AiResearch cooling of airborne detection systems is accomplished by an extremely reliable, compact unit which is both an air-cooled cold plate and mounting structure for the detection system's transistorized power supply.

This lightweight package weighs 7.2 lb., and has a heat rejection of 500 watts. It consists of four AiResearch Minifans and an all-aluminum structure with 44 separate modules. Each module is electrically isolated and may be removed individually for quick, easy replacement.

AiResearch is the leading designer and manufacturer of such advanced electronic conditioning equipment and systems. This production unit is one example of the broad production-proven capability of AiResearch in providing extremely reliable, lightweight, compact cooling packages for aircraft, missile, space and ground support applications.

Environmental conditioning equipment has been produced for the following electronic systems:

Detection · Communication · Control · Ground Support · Guidance

Write for literature today.

THE GARRETT CORPORATION

AiResearch Manufacturing Division

Los Angeles 45, California

Trade Literature

(Continued from page 38A)

cording voltmeter are available in a 2-page illustrated catalog sheet. It gives details and operating advantages and compares voltage charts recorded by the Brenner-Fiedler unit with charts recorded using a rectifier voltmeter and a dynamometer voltmeter. Specifications provide complete information on ranges, accuracy, controls, power connections, sizes, and weight. The new unit is designed for monitoring voltage fluctuations and provides chart deflections with amplitudes two to three times greater than standard voltmeters. *Brenner-Fiedler & Associates, Inc., 7563 Melrose Ave., Los Angeles 46, Calif.*

Combustion Control Systems . . .

A 32-page Bulletin 1001 presents a clear analysis of the two main groups of combustion control systems, proportioning and metering. With concise block-diagrams of each system, the guide describes the system, points out its advantages for a specific application, then gives a brief description of its operation and suggested mounting procedures. The systems chosen are of typical proportioning and metering combustion control installations, proceeding from the most basic, to special systems for more complex requirements. *Reliance Instrument Division, Electro-Mech Corp., Norwood, N.J.*

Microminiature Telemetry Switch . . .

A 6-page technical bulletin (IOS) describes a microminiature 450-circuit telemetry switch, its design features, operating characteristics, and environmental performance as well as pertinent dimensions. A graph and diagrams complement the section on operating characteristics, and a large cutaway view shows the internal working parts of the new switch. Included in the bulletin is a handy self-mailing "specvelope" allowing engineers to detail their particular telemetry switch requirements. *Electro-Tec Corp., 10 Romanelli Ave., South Hackensack, N.J.*

Fractional Horsepower Motor . . .

An 8-page bulletin gives a comprehensive description of the construction and design details of the new Duty Master FHP. Each point is illustrated with photos and drawings, and a life size photo of a cutaway motor is shown in full color. According to the company it offers a new ventilation system that makes it up to 10% cooler than other comparably rated motors. Weight has been reduced 33% from preceding motor designs. It provides maximum protection in enclosure with compact magnetic electrical parts designed to produce size and weight reductions. *Reliance Electric and Engineering Co., Cleveland 17, Ohio.*

Transistor Reliability . . .

Reprints of "Transistor Reliability" published in the December 1960, *Electronics World* are now available. Illustrated with photographs, the 4-page article describes basic transistor reliability and the steps Motorola has taken toward a failure rate of only 0.0007% per 1,000 hours. Copies may be obtained by writing to the *Technical Information Center, Motorola Semiconductor Products Inc., 5005 E. McDowell Rd., Phoenix 10, Ariz.*

Black Glass for Diodes . . .

Information on a special black glass for encapsulating diodes is given in a new 8-page brochure. The illustrated booklet says the black glass, which is available as beads and as cases, protects diodes that are sensitive to visible and infrared wavelengths. Transmittance and other properties are detailed in a chart and a table. Information includes sizes, sealing techniques, and recommended applications. *Corning's Receiver Bulb Sales Department, Corning, N. Y.*

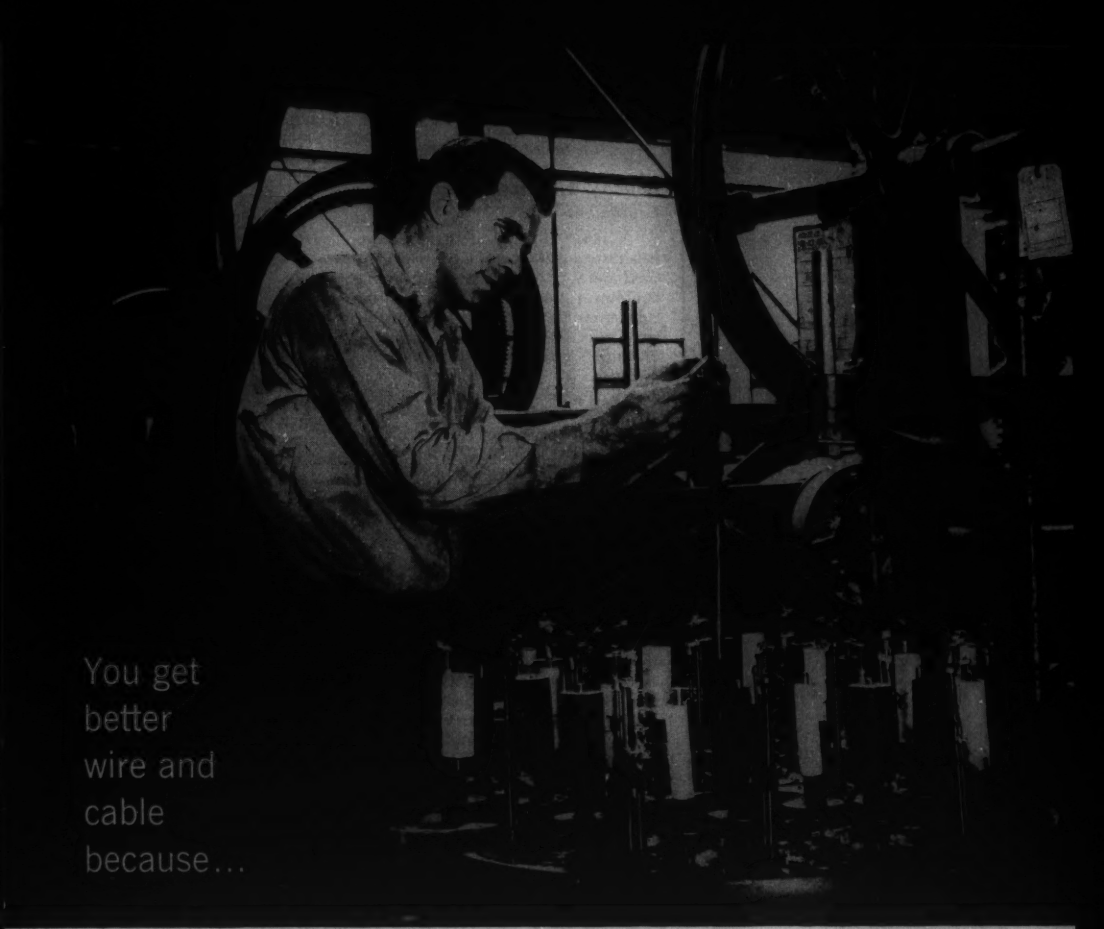
Operating Ratios . . .

"14 Important Ratios in 72 Lines of Business" is a comprehensive annual study of operating ratios averaged from a wide sampling of retailers, wholesalers, and manufacturers. For the first time in a single source, the ratios are complemented with text fully detailing their usage and meaning, how they are compiled as well as how they may be interpreted. The complete study is available in pamphlet form to interested business men, libraries, banks, schools, and services from *Dun & Bradstreet, Inc., 99 Church St., New York 8, N. Y.*

Nondestructive Testing of Small Tubing . . .

Reprints of an 8-page article entitled "Nondestructive Testing of Small Tubing," published in the December 1960 issue of *Metal Progress*, are available. The article gives a short description of how various nondestructive tests are applied and describes their advantages and limitations. The tests include visual magnification, boroscope, eddy current, dye penetrant, magnetic particle, ultrasonic, radiographic, and hydrostatic. Included is a 2-page table which rates each test with respect to its most important factors, such as cost of equipment and materials, skill required, and speed of testing. *Superior Tube Co., 1517 Germantown Ave., Morristown, Pa.*

(Continued on page 44A)



NEARLY EVERYONE AT CIRCLE'S AN "INSPECTOR"

Take Oscar Stangoni, braiding machine operator at Circle.

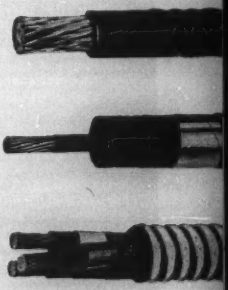
Mr. Stangoni doesn't need to use a micrometer. Ordinarily, his foreman sets up the machine, checks with a "mike" at the beginning of a run and several times during a run to make sure that the O.D. is OK.

But Oscar Stangoni uses one just the same—and he uses it often. Why? Maybe pride or a sense of responsibility—or maybe just because he feels better when he also knows the cable is absolutely right.

This is just one of many ways in which Oscar Stangoni and hundreds more like him at Circle make sure that the wire and cable they turn out is as good as it can possibly be.

And that's another reason, we believe, why Circle products have achieved their reputation for quality.

Next time you specify cable, we suggest you ask for Circle. There's no finer cable made. CIRCLE WIRE & CABLE CORP., Maspeth, N. Y.



CIRCLE WIRE & CABLE CORP.

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SALARY: TO $20,000

Several immediate openings exist in Hughes-Fullerton's new Computer Laboratory for Circuit Engineers qualified in transistor circuitry design and semiconductor power supply design in connection with the design and development of large scale digital computers and digital systems.

These professional assignments involve such R & D areas as:

- Solid state digital circuitry involving millimicrosecond logic
- Microwave carrier digital circuits
- Sub-microsecond core memory
- Thin film storage techniques
- Functional circuit concepts
- Micro-miniaturization concepts
- Tunnel diodes
- Microwave parametrons
- Circuit organization for maximal-speed computing.

Located in Southern California's Orange County, (the nation's fastest growing electronics center), Hughes-Fullerton offers you a stimulating working environment, private or semi-private offices, long-term stability.

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Or, airmail resume to: HUGHES-FULLERTON R & D, P. O. Box 2097, Fullerton 1, California.

HUGHES

Trade Literature

(Continued from page 40A)

Catalog On Instrumentation Equipment . . .

A new, 71-page, 855-item catalog lists instrumentation and other electro-mechanical components including equipment manufactured by leading companies. Catalog items are available from stock with full guarantee to manufacturer's specifications. The company specializes in inventories of instrumentation equipment for measuring pressure, force, temperature, acceleration, rotary-linear displacement, recording devices, and associated telemetering equipment. Stocks are also maintained in synchros, motors, inverters, amplidynes, pneumatic, and hydraulic controls. *AST Co., Inc., 150 Fifth Ave., New York 11, N. Y.*

Photography in Engineering . . .

The miniature-type camera has found many new and valuable applications in today's complex manufacturing and research organizations. A 58-page book entitled "The Miniature Camera, A Major Research Tool" by Walter and Shultz graphically illustrates and clearly defines a wide range of topics that are pertinent to the field. Using the new Praktina camera as its basis, the publication describes and illustrates the latest research techniques and applicable photographic accessories. Also, the field of macro-photography and photo-micrography are discussed in detail. *Standard Camera Corp., 319 Fifth Ave., New York 16. N. Y.*

Hydrogen Thyratrons . . .

General theory and application of hydrogen thyratrons is discussed in a 20-page bulletin "Hydrogen Thyratrons: Theory and Application." Schematics, graphs, and charts detail the construction, operation, applications, and characteristics of hydrogen thyratrons. The booklet contains complete technical descriptions and data for the *GL-7390, GL-7390-A* and the *GL-7890. Power Tube Dept., General Electric Co., Schenectady 5, N. Y.*

Service-Entrance Equipment . . .

A new bulletin details the operating and safety requirements of service-entrance equipment. Entitled "Facts You Should Know About Service-Entrance Equipment," it covers the three basic aspects of the service-entrance function: current-carrying efficiency (including heat rise at contacts), manual switching facility (under adverse conditions that include overloads), and speed and capacity of short-circuit interruption. It also has a section on the design provisions necessary for limiting and confining arcing during manual operation. Sample specifications are given to cover all the important operating requirements. *Pringle Electrical Manufacturing Co., Inc., Dept, 95, 1900 N. Sixth St., Philadelphia 22, Pa.*

Alpha-Numeric Display . . .

A 2-page bulletin (B262) contains information on solid-state alpha-numeric display. Included in the bulletin is a description of the electrical operation and display properties. Illustrations cover operational block diagram, modular printed board arrangement, segment configuration, and alpha-numeric gate line coding. *Robotomics Corp., 2422 E. Indian School, Phoenix, Ariz.*

Table of Properties . . .

This table, reprinted from Modern Plastics Encyclopedia, shows significant physical, electrical, chemical, and optical properties of nine thermoplastic materials. Materials covered are acrylics, acetate, butyrate, Teflon and Kel-F fluorocarbons, nylon, polyethylene and vinyls. Data is compiled from test reports submitted by manufacturers. Properties shown include: tensile, impact, flexural and compressive strength; resistance to sunlight, water, weak and strong acids and alkalies; dielectric short-time strengths and constants; power factors; machining qualities, hardness, flexibility and thermal properties. *Cadillac Plastics & Chemical Co. 15111 Second Ave., Detroit 3, Mich.*

"Transformer Tips" Manual . . .

A 52-page pocket manual gives general information, operating and maintenance tips and connections for pole-type distribution transformers. The 3⅝- by 6⅞-inch booklet also carries tables and charts covering pole-type transformers 167 kva and smaller, 15,000 volts and below. Its contents are particularly directed to distribution system operation personnel and should be helpful as a training aid. *Allis-Chalmers Mfg. Co., Milwaukee 1, Wis.*

Passive Repeaters . . .

A new 48-page "Passive Repeater Engineering Manual" No. 161, intended for use by microwave systems engineers and others concerned with the application of passive repeaters describes in detail the use of passive repeaters and provides the technical data necessary to design passives into the microwave systems properly. Complete specifications on the company's line of passive repeaters for systems

(Continued on page 45A)

(Continued from page 44A)

from 2,000 to 12,000 mc are included as well as sample calculations to illustrate clearly the technical information contained in the manual. *Microflect Co., Inc., 3450 25th St. S. E., Salem, Ore.*

Self-Locking Fasteners . . .

New Aerospace Catalog No. 960 is a 64-page design manual which focuses attention on reduced dimension, lightweight types of self-locking fasteners. Its purpose is to provide the design engineer with a concentrated package of nut shapes covering complete lines of miniature hex, anchor, and clinch types which experience has shown to be useful in the assembly of units intended for avionic and electronic end use. Special emphasis is placed on clinch types of Elastic Stop nuts including a new "floating" type of blind fastener and two new right-angle bracket nuts suitable for panel and cover assemblies. Complete instructions on "how to install" clinch nuts are presented; available tools and production methods are illustrated. *Elastic Stop Nut Corporation of America, 2330 Vauxhall Rd, Union, N. J.*

Flow-Behavior of Plastic Substances . . .

A 5-page pamphlet entitled "The Real Flow-Behavior of Plastic Substances," by Dr. A. G. Epprecht includes a complete technical discussion of the subject, collected from the author's many lectures on the subject of rheology and was published to promote an awareness of the need for a better understanding of the "solid-liquid-solid" or viscous deformation of plastic substances. *Drage Products, Inc., 406 32nd St., Union City, N. J.*

Economic Automation . . .

A 4-page 2-color brochure describes new "economic automation processes" in soft soldering and silver brazing. The brochure describes the unique method of automating production soldering and brazing operations with paste alloys, describes briefly three series of paste materials available, and gives four case history examples of cost savings achieved through installation of "automatic," "semi-automatic," and "manual" equipment. In "automatic" installations, cost savings of $25,000 and $18,000 per year are illustrated with investments of $3,500 and $2,500 respectively. With "semi-automatic" installation, savings of $10,000 per year with an equipment investment of $450 is shown. *Fusion Engineering, 17921 Roseland Ave., Cleveland 12, Ohio.*

Switches . . .

"Uses Unlimited, Vol. 12, No. 2" is the latest issue of the company's publication aimed at the design engineer and other users of precision switches. This issue includes descriptions of many new types of switches, including miniature sealed limit switches for aircraft, missiles, railways, marine, and other applications, and "bounce-free" electronic switches that eliminate spurious pulses caused by contact bounce in pulse or digital systems. Helpful application examples described include church lighting, a tensile tester, automatic mail sorting, an electronic setworks for lumber mills, central control of individual motel units, and even an automatic maple sugar farm. Another article tells of the use of switches on Pioneer V's historic journey around the sun, while still another describes a fuel loading system for Atlas missiles. *Micro Switch, Div. of Minneapolis-Honeywell Regulator Co., Freeport, Ill.*

Paper Capacitor Catalog . . .

A new 6-page catalog contains complete physical and electrical characteristics of the company's high-temperature metallized paper capacitors. Catalog 131B8 features types which are now capable of operation to +125C without voltage derating. Temperature characteristics curves and performance characteristics tables are included, along with complete size charts and case style diagrams. *Aerovox Corp., New Bedford, Mass.*

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